KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
SIMPLY WORDED—EXACTLY DESCRIBED

LONDON: DECEMBER 1, 1892.

CONTENTS.

PAGE

Armadillos and Aard-Varks. By R. LYDEKKER, B.A.Cantab. 221
On the Distribution of Stars in the Milky Way. By JOHN RICHARD SUTTON, B.A.Cantab. 224
Caterpillars—II. By E. A. BUTLER 226
Photographs of Swift's Comet. By Prof. E. E. BARNARD 229
On the Forms of Comets' Tails. By A. C. RANYARD ... 229
Science Notes. 231
Recent Trade and the Nation's Drinking Habits. By ALEX. B. MACDOWALL, M.A. 232
Notices of Books 234
Letters:—W. F. KIRBY; W. T. LYNN; W. H. S. MONCK ... 235
The Face of the Sky for December. By HERBERT SADLER, F.R.A.S. 238
Chess Column. By C. D. LOCOCK, B.A.Oxon. 239

ARMADILLOS AND AARD-VARKS.

By R. LYDEKKER, B.A.Cantab.

OF the three animals represented in the figures accompanying the present article, two are sufficiently alike to suggest to the ordinary observer their relationship to one another, but the third is so utterly different, that it is difficult to point out any important character it has in common with the two others; nevertheless, naturalists generally regard all these three strange creatures as belonging to a single order of mammals, for which the name of Edentata is adopted.

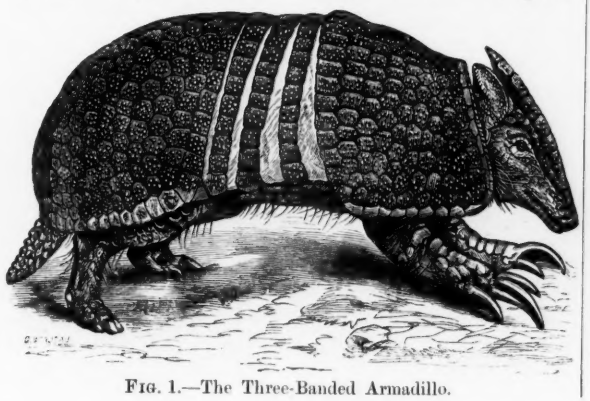


FIG. 1.—The Three-Banded Armadillo.

The signification of the term Edentata being toothless, the unsophisticated student would naturally be led to suppose that all the animals so named were utterly devoid of those useful but troublesome appendages. This, however, is far from being the case, the majority of the members of the group (among which are those figured here) having a considerable number of teeth. Still there is one feature in connection with the dentition exhibited by the whole of these so-called edentates; and this is, that teeth in the front of the jaws, corresponding to the incisors of other mammals, are totally absent. Instead, therefore, of being described as edentates, or toothless mammals, these creatures ought rather to have been named aprotodonts, or incisorless mammals. After all, however, it is not much consequence what is the proper meaning of a name, so long as we know the sense in which it is used, and there is accordingly no real objection to the employment of the term edentates, which has obtained the almost universal sanction of zoologists.

In addition to this total absence of front teeth, the edentates are further characterized by the circumstance that all their teeth (when they possess any) show no trace of the hard layer of enamel which is so characteristic and essential a constituent of those of other mammals; these teeth at no period of life forming roots, but continually growing from below. Moreover, in nearly all the edentates there is never any set of milk-teeth developed, although, unfortunately, this cannot be taken as a characteristic of the order, since such teeth occur in one of the armadillos, and also in the animal represented in our third figure.

Premising that the edentates are quite distinct from the marsupials and egg-laying mammals, we may say, then, that the only features by which they can be collectively characterized are the want of front teeth, and the absence of enamel on those of the cheek-series, while in certain rare instances they may be utterly devoid of teeth. Such characters, it must be confessed, are by no means of first importance.

The mammals thus associated by these negative characteristics are now chiefly confined to the southern hemisphere, and include the sloths, anteaters, and armadillos of South America, the pangolins, or scaly anteaters of South-eastern Asia and Africa, and the aard-varks of Africa; the true anteaters and pangolins being those in which teeth are wanting. In past times they were also represented by the gigantic megathere, and a number of other allied extinct forms ranging throughout America, which in some respects serve to connect the sloths with the anteaters. This marked restriction of the existing edentates to the southern hemisphere, and their especial abundance in South America, at once stamps them as a very lowly group of animals, there being a well-marked tendency for the preservation of the humbler forms of life in the southern continents and islands of the globe. There is, indeed, a question whether the pangolins, and more especially the aard-varks of the Old World, have any real kinship with the more typical American edentates, but apart from this possibility of the artificial nature of the group as at present constituted there can be no doubt but that all its members are what may be called degraded types—that is to say, that instead of having advanced in the struggle for existence they have lost some of the attributes of the higher animals; evidence of this degradation being afforded by the indications above mentioned of their having been formerly provided with two sets of teeth. In saying that the edentates are lowly and degraded examples of the mammalian type we by no means intend, however, to imply that they are not admirably adapted to

their own particular modes of life, or that they have not developed special structures unknown among the higher mammals. In truth, precisely the contrary is the case, since these creatures have taken to modes of life unlike those of the majority of the larger mammals, and have more or less specially modified their structure in accordance with such peculiar habits, so that they are thoroughly and perfectly suited to their environment. And we may add that it is doubtless due to these peculiarities of structure and habits that they have been enabled to survive and hold their own against the competition of the higher forms.

Thus, in the first place, with the exception of a few armadillos, the whole of the edentates are strictly nocturnals; and while the sloths spend the whole of their lives among the branches of the dense forests of South America, all the others have taken to a burrowing subterranean life. Moreover, as we have noticed in an earlier article on "Mail-Clad Animals," the armadillos and the pangolins have acquired a special protection from their foes in the shape of a bony or scaly armour, which is a perfectly unique feature in the whole mammalian class. Another peculiarity of the group is that no less than three distinct sections of its members—namely, the anteaters of South America, the pangolins of Southern Asia and Africa, and the African aard-varks—have taken to feed mainly or exclusively on termites, or so-called white ants. This practice obviously gives them an advantage in the struggle of existence, since, with the exception of the marsupial banded anteater and the egg-laying spiny anteater of Australia (with which, of course, they do not come into competition), no other mammals are in the habit of subsisting exclusively on those insects. And we may notice here that of the three groups of termite-eating edentates, two—namely, the pangolins and the anteaters—are those which have entirely lost their teeth; while in the aard-varks those organs are retained. As teeth are obviously of no sort of use to animals subsisting on such a diet, we may regard the two former groups as those most specially modified for their particular mode of existence; and it may thus be suggested that they have taken to termite-eating for a longer period than the aard-varks. A similar observation also applies to the banded and spiny anteaters of the antipodes, the former retaining a number of minute teeth, while in the latter they have completely disappeared. Needless to say, all termite-eating mammals, whether they be edentates, marsupials, or egg-layers, have extremely long, narrow, and extensile tongues with which to pick up their insect-food; but the presence of such an organ does not, of course, imply any mutual affinities between the possessors thereof, and is merely an instance of the similarity of organs arising from adaptation to a similar mode of existence. The tongue of the aard-varks is, however, far less elongated and extensile than that of the pangolins and true anteaters; and, therefore, tends to confirm our suggestion as to the relative duration of time since the ancestors of these creatures severally took to termite-eating. Another instance of adaptation displayed by all the edentates, except the arboreal sloths, is to be found in the powerful and generally elongated claws or nails with which their feet are armed, such claws being obviously necessary for a fossorial subterranean existence. The aard-varks, as will be seen from our third figure, have, however, much shorter and blunter claws than any other member of the group; and this leads me to hazard the suggestion that, in addition to having taken at a comparatively late period to termite-eating, these animals have not been accustomed to a subterranean life for so long a time as their reputed kindred.

Having said thus much as to edentates in general, we must turn to the special consideration of the creatures whose names form the title of this article.

The armadillos, as their name (a Spanish one) implies, are distinguished by the solid armour with which their heads and backs are protected; and it is doubtless the peculiar appearance presented by these animals to which we owe the expression "hog-in-armour." In all the armadillo family the armour takes the form of a series of thicker or thinner bony plates embedded in the skin covering the head and back, and overlain by horny scales; while the under parts of the body and limbs are hairy, and in many species a larger or smaller number of stiff hairs protrude from between the joints of the armour. This bony armour is a perfectly unique feature among existing mammals; and since each plate is ornamented with a more or less elaborate sculptured pattern, such armour when cleaned by maceration forms a most beautiful object. In the true armadillos, as the one represented in Fig. 1, the shield of armour covering the head is quite distinct from that of the body; while the latter is divided into three distinct portions, namely, a large solid shield covering the fore-quarters, and separated by a larger or smaller number of free movable bands occupying the middle of the body from a nearly

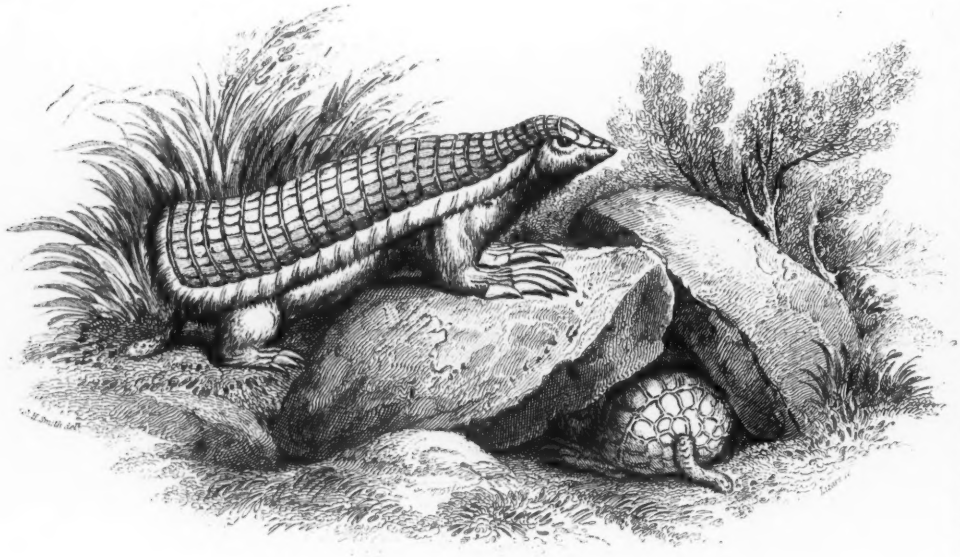


Fig. 2.—The Pichiciago. (From Jardine.)

similar shield protecting the hinder portion of the animal. In our figured example the number of the movable bands is only three, but they may vary from six to nine up to as many as twelve or thirteen in other species. In one extinct armadillo there were, however, no solid shields, the whole body being covered by a series of thirty-two movable bands. The latter species evidently, therefore, leads on to the rare and beautiful little creature represented in our second illustration, which rejoices in the name of pichiciago. In this tiny animal, which is only about five inches in length, and has a pink-coloured armour above, and long silky white hair below, the armour of the head and body forms a continuous shield of horny plates underlain by very thin plates of bone, and is attached only to the middle line of the back, so that the lateral portions form a kind of cloak loosely overhanging the hairy sides of the body. The hinder end of this cloak is abruptly truncated, and beneath it the hind-quarters of the animal are protected by a solid bony shield, through a hole in the centre of which protrudes the small cylindrical tail. When the animal creeps beneath a crevice in rocks, as shown in the right hand corner of our illustration, which is not sufficient to conceal its whole body, the strong shield on the quarters affords an ample protection against all attacks. The pichiciago is found on sandy plains only in the western portions of the Argentine pampas. It will be seen from our illustrations that this creature also differs from the true armadillos in the absence of the large external ears which form such a characteristic feature in the physiognomy of the latter.

Reverting to the true armadillos, we find that the majority of the species protect themselves from attack by squatting on the ground, and tucking their limbs within the shelter of the edges of the armour of the body, while the plated head is drawn as close as possible to the front shield. On the other hand, the species represented in our illustration has the power of rolling itself up into a complete ball, like the pill-millipedes of our own country, the wedge-shaped head and tail fitting most perfectly side by side into the deep notches of the front and hind shields. Thus coiled up, the three-banded armadillo is safe from most animals except man. Trusting in this immunity from attack, this armadillo, together with two other species inhabiting the Argentine, has become almost exclusively diurnal in its habits. These diurnal habits, as Mr. W. H. Hudson, in his charming work, "The Naturalist in La Plata," suggests, may also have had the advantage of avoiding any encounters with the larger animals of prey, which are mostly nocturnal, and some of which may have been able to break through the protecting armour, more especially in the species which lack the power of rolling themselves up. Whatever advantage may have formerly accrued from these diurnal habits before the appearance of man on the scene, is, however, now completely lost in cultivated districts, where these species stand a good chance of being completely exterminated by the hand of man.

On the other hand, the six-banded pelado, or hairy armadillo, of the Argentine, which differs from its cousins in preferring an omnivorous diet to one of insects, is a far wiser beast in its generation. This creature, according to Mr. Hudson, adapts itself to the conditions under which it exists, and thus stands a good chance of surviving when its fully-armoured relatives perish. "Where nocturnal carnivores are its enemies," writes the observer mentioned, "it is diurnal; but where man appears as a chief persecutor, it becomes nocturnal. It is much hunted for its flesh, dogs being trained for the purpose; yet it actually becomes more abundant as population increases in any district." Another writer says that beneath any decomposing carcase lying in the Argentine pampas, the burrow of a pelado is almost sure to be found; and it is not a little remarkable that the flesh of a creature which has such unpleasant tastes in the matter of diet, should be so eagerly sought after as an article of human consumption.

Before taking leave of the pelado we must not omit to mention two other peculiar habits which are recorded of it by Mr. Hudson, since these also mark it as a creature far above the generality of its kind in point of intelligence. The first of these peculiarities is the ingenious way the creature catches mice, by approaching them with extreme caution, raising itself on its hind-quarters, and then suddenly proceeding to "sit down" on the unfortunate rodents, which become entrapped under the projecting edges of its armour. The sharp edges of the armour are also brought into requisition when this armadillo attacks a snake preparatory to devouring it; the snake being pressed close to the ground beneath the edges of the bony plates, and literally sawn to death by means of a backwards-and-forwards motion of the body of its assailant.

The largest of living armadillos is one which inhabits the moist forests of Brazil and Surinam, and has a length of about 36 inches, exclusive of the unusually long tail, which is some 20 inches in length. These dimensions were, however, vastly exceeded by some extinct armadillo-like animals, of which the remains are found in the caverns of Brazil. The most gigantic of these creatures, which flourished during the pleistocene epoch—the period *par excellence* of giant mammals—is estimated to have been nearly equal in size to a rhinoceros, and has been named the chlamydothere. The armour appears to have been very like that of the true armadillos, but the bony plates measured as much as five and six inches in length, in place of little more than an inch. The teeth differed, however, from the simple conical ones of the modern armadillos, and more nearly resembled the vertically fluted ones characteristic of the extinct glyptodonts. Unfortunately, space does not admit of further reference to the gigantic creatures from the pleistocene of South America, to which the latter name has been applied, all of which are distinguished from the armadillos by the armour of the body being welded into a single solid dome-like shell, of which a specimen is figured in the article on "Mail-Clad Animals."

Passing on to the animals whose name comes second in the title of this article, we have first of all to mention that the designations by which these creatures are commonly known exhibit that remarkable want of originality in nomenclature which appears to be characteristic of Europeans when they are brought for the first time into contact with hitherto unknown animals. Thus, whereas the Dutch Boers of South Africa applied to the creatures in question the title of "aard-vark" (meaning "earth-pig"), the English colonists of the Cape commonly speak of them as the ant-bear. Now, if there is any one particular animal which the aard-vark (as we must perforce term the creature) is unlike, it is a bear; while its resemblance to a pig is only of the most distant kind. Still, however, as in the case of the order to which it belongs, we must be content to designate the animal by the name by which it is most commonly known.

In appearance, aard-varks, of which there are two species, are decidedly ugly creatures, having thick ungainly bodies, a long pointed snout, enormous erect ears, and a thick cylindrical and tapering tail, nearly as long as the body. The skin is either almost naked, or thinly covered with bristle-like hairs. The fore feet have but five toes, which are armed with broad and strong nails, as

XUM

are the five toes of the hind limb. As we have already mentioned, almost the only feature which the aard-vark has in common with the armadillos is the absence of front

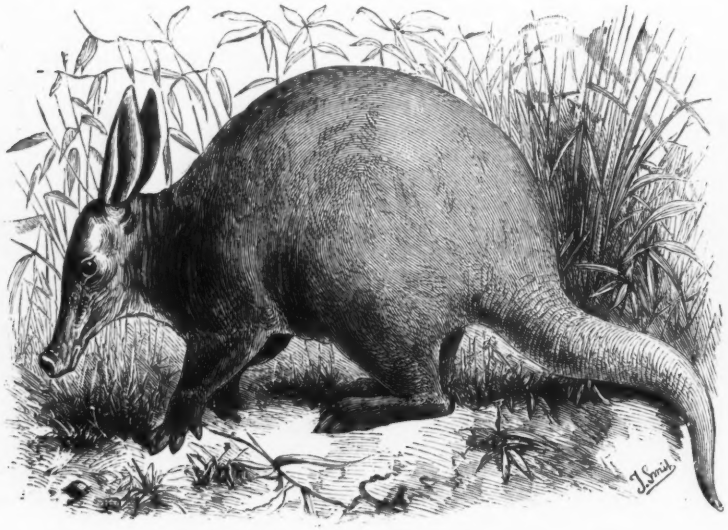


Fig. 3.—The Ethiopian Aard-Vark. (From Sclater, *Proc. Zool. Soc.*)

teeth, and its cheek-teeth are quite unlike the simple ones of the latter, as, indeed, they are dissimilar to those of any other mammals. In the first place, they are preceded by a functionless series of milk-teeth (a feature found elsewhere among edentates only in one species of armadillo), while in the second place the premolars are unlike the molars. The latter are composed of a number of closely packed denticules, each furnished with a central pulp cavity, and by their close approximation forming polygonal prisms, so that a cross-section of one of these teeth presents the appearance of a pavement. No dental structure among mammals is at all comparable to this, although there is some approximation to it among certain fishes.

Of the two living species of aard-vark, one is confined to South Africa, while the other (represented in our figure) inhabits part of Egypt and other districts in the north-western portion of the same continent. A third species occurs fossil in the pliocene deposits of the Isle of Samos, but with this exception the palæontological record is silent as to the past history of these strange creatures, as to whose origin and relationship to the other animals we are at present utterly in the dark. Indeed, the aard-vark is placed among the edentate mammals chiefly because zoologists do not know where else to put it, and they take that group as a kind of refuge for the destitute. Were it not that the burdening of zoological science with new names is from all points of view to be deprecated, there is, indeed, much justification for regarding these animals as the sole representatives of a distinct order, but, although in some ways such a new departure would be convenient, I do not know that in others it would be of any great advantage. But in including them provisionally among the edentates we have to recollect that their affinities with other members of that group—not even excepting the pangolins—must be extremely remote.

Aard-varks lead what would seem to us a very dull and monotonous kind of life, passing the whole of the day curled up in their deep burrows, which are generally excavated hard by the tall pyramidal hills made by the termites, and only issuing forth at night to dig in the mounds for their favourite insect-food. Not a great many years ago it used to be said at the Cape that wherever a clump of termite hills was to be seen there an aard-vark's burrow might be pretty confidently expected. Unfortunately, however, as we learn from a recent report of the Agricultural Department of the Cape Colony, this is no longer the case, and the aard-vark of that district runs a good chance of being exterminated at no very distant date.

This deplorable result is being brought about by the incessant pursuit of these animals by the natives for the sake of their hides and flesh, and also to their being dug out by Europeans for so-called sport. Their flesh is said to be excellent, and is compared to superior pork; while the value of each hide is about fifteen shillings. This threatened extermination is a very short-sighted policy on the part of the South African farmers, to whom the aard-vark (as the report before us points out) is a valuable ally, not only on account of the enormous number of termites it consumes, but likewise from the circumstance that while it is engaged in digging for these insect-pests it covers with loose earth a quantity of the seeds of grass and other pastoral herbage which would otherwise perish during the hot season. Although there is no likelihood at present of the Ethiopian aard-vark sharing the threatened fate of its southern cousin, yet the extermination of the latter would be a sad loss to zoological science, and we therefore wish every success to a movement which we hear has been set going by the Cape Farmers' Association for the protection of this most strange and curious creature ere it be too late.

ON THE DISTRIBUTION OF STARS IN THE MILKY WAY.

By John Richard Sutton, B.A.Cantab.

Several considerations seem to point to the conclusion that the galaxy must be generally of a roughly circular section; for if we imagine the true depth of the galaxy along the line of sight to be considerably greater than its true breadth (a form to which Sir John Herschel inclined after his study of the stars in the southern hemisphere), we should have, since the sides of such a figure would probably not be smooth, but would be crowded with excrescences and streamers, a great degree of brightness along the central line of the Milky Way throughout its whole length, and a rapid shading off to the edges; and the greater the depth of the Milky Way along the line of sight, the more would this aspect be exaggerated. On the other hand, if the galaxy be of roughly circular section, the decrease of brightness would be much more gradual—which is indeed the case.

Perhaps Figs. 1 and 2 will make this clearer. Let S be the sun; SA, SB, SC, SD, lines in a plane through the sun at right angles to the direction of the galaxy G; a, b, c, streamers. We see that in Fig. 1 the brightness along SA and SD would be considerably less than along SC, which again would be considerably less than that

along SB.* In Fig. 2, however, the corresponding effect would be much less marked. To these considerations may

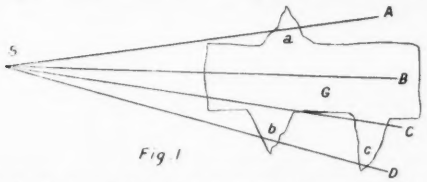


Fig 1

be added that pointed out by the late Mr. Proctor, that the galactic coal-sacks and lacunæ are altogether against any great depth along the line of sight.

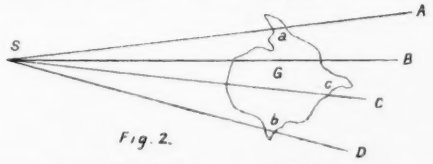


Fig. 2.

It seems to me that the strength of this argument (such as it is) gives us something more than a clue to where the greatest proportion of the mass of the Milky Way may be found.

Let us, at a venture, in the absence of any trustworthy evidence one way or the other, make a similar assumption to Sir William Herschel's, and assume the stars to be uniformly distributed throughout the whole Milky Way. Let O P, O Q (Fig. 3) be lines of sight bounding any

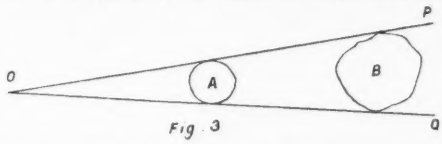


Fig. 3

galactic area. The actual distance of this area is unknown, it may be at A or at B, or since the average angular breadth of the galaxy is nearly constant everywhere, let us assume that A is a portion of it from one part of the sky at a certain distance, and that B is a portion from another part of the sky at another distance. A and B are of the same angular dimensions. We want to compare the brightness of A and B on the assumption that each contains the same number of stars in a given volume. Let d and D be the true distances of A and B, δ and Δ their diameters; then

$$\begin{aligned} \text{Volume of A : volume of B} &= \delta^3 : \Delta^3 \\ &= d^3 : D^3 \\ &= d^3 : n^3 d^3 \\ &= 1 : n^3 \end{aligned}$$

where $D = n\,d$.

But the brightness of each star in B will be reduced in the proportion of $D^2 : d^2$, that is as $n^2 d^2 : d^2$, that is as $n^2 : 1$. Therefore the brilliancy of B will be to that of A in the proportion of $n : 1$. In other words, on the assumption of uniformity of distribution, the brightness of the different parts of the Milky Way would vary as the distance. It has been shown (see KNOWLEDGE for February, 1891) that the brilliancy of a given sheet or volume of stars will remain constant whatever its distance; and this fact has been used to controvert Proctor's spiral theory of the Milky Way. For the main argument for the spiral theory was based upon the erroneous conclusion that the faintness of the great branching streams from the Milky Way was due to an approach to "evanescence through vastness of distance." But on the assumption of a uniformity of distribution, it would be necessary (since the angular breadth of the great branching streams is not materially less than that of the main stream) that these streams, if part of a spiral, should be considerably brighter than the rest of the galaxy,† unless, indeed, the distribution decreased with distance from the sun: an arrangement not altogether impossible perhaps, if we could regard the sun as in some way the mainspring of the whole visible universe.

It will be noticed, however, that the calculation above involves, in fact, Sir William Herschel's other and later hypothesis of a general equality of real size among the stars. If the Milky Way stars are collected into groups of different orders, *i.e.*, if stars of one size segregate into one region, those of another size into another region—a tendency which seems to obtain, to some degree, among the sporadic stars in various parts of the sky—a considerable modification must be introduced into our result. Consider two stars S and s, of masses m and 1, and diameters Δ and δ respectively, at equal distances from the sun. Let their brilliancy, surface for surface, be the same. Then we have—

The total brightness of S : the total brightness of s as the surface of S : surface of s, that is as $\Delta^2 : \delta^2$, but $m : 1 = \Delta^3 : \delta^3$ if the densities are the same.

Therefore $\Delta^2 : \delta^2 = m^{\frac{2}{3}} : 1$.

Therefore the total brightness of S : the total brightness of s as $m^{\frac{2}{3}} : 1$.

If now we could suppose the *mass* of any given volume of the Milky Way to be constant, for every star (S) in the one place we should have m stars (s) in the other place. Hence—

$$\begin{aligned} \text{The total brightness of S : the total brightness of } m \text{ s} &= m^{\frac{2}{3}} : m \\ &= 1 : m^{\frac{1}{3}} \end{aligned}$$

so that, on the assumption of equal surface brilliancy, the region containing the smaller stars would be brighter in the ratio $m^{\frac{1}{3}}$ to unity, and it follows that the ratio of the brightness of A to the brightness of B (referring again to the notation of Fig. 3) will be as unity is to $n\,m^{\frac{1}{3}}$, or as $m^{\frac{1}{3}} : n$, according as the smaller stars are found in B or A. In the latter case, if m be greater than n^3, A would be brighter than B. If, then, the galactic stars collected rigorously in classes of magnitude, it would be clear that the brightness, taken alone, of the Milky Way, would have no immediate significance in the present state of our knowledge.

That the galactic stars do collect into minor sheets and volumes of one particular star-magnitude, may be admitted without prejudicing the fact that over any extended region such a tendency is not obvious. Individuality, so to speak, becomes lost in the crowd. Photography adds its testimony to telescopic observation, that the average magnitude of the stars belonging to the Milky Way proper, in any given region, will be about equal to the average star-magnitude of the whole ring. That is to say, if we take a

* Nor would the optical effect be materially different on the view that the Milky Way is a collection of clouds, one behind the other, for a vast distance along the line of sight. I do not contend that it has not this particular cloud structure; what seems certain is, that if it has, the clouds can neither be far apart nor numerous, nor of great individual depth. But see Mr. Ranyard's article in KNOWLEDGE for July, 1890.—J. R. SUTTON.

[† This ingenious reasoning of Mr. Sutton leaves out of account the absorption of light in its transmission to us from distant parts of space. It seems very improbable that the loss of light due to absorption should just balance the increase of brightness of the stream due to its greater thickness, especially when great distances are involved, for the absorption would increase according to an exponential law, while the brightness would, according to Mr. Sutton's assumptions, only increase directly as the distance.—A. C RANYARD.]

XUM

large area of the Milky Way, and divide all the stars we are able to detect in it with a given power, into half a dozen classes of an ascending order of magnitude, containing, say, a, b, c, d, e, f stars respectively in each class, then the ratio $a : b : c : d : e : f$, is nearly enough constant for the same magnitudes over the whole Milky Way.

We have, then, some reason for the inference that we may reason upon the Milky Way stars as upon an equal number of stars of a standard size equal to the average magnitude of the true Milky Way stars. In short, if the Milky Way have a stars giving p units of light each, b stars giving q units of light each, c stars giving r units of light each, &c., we may for present purposes regard it as consisting of $a+b+c+\ldots$ equal stars each shining with $\frac{(ap+bq+cr+\ldots)}{(a+b+c+\ldots)}$ units of light, and this fraction may be regarded as the standard star for any galactic area of considerable extent, leaving the lucid stars, of course, out of consideration.* May we, therefore, argue with equal confidence for an equality of distribution? Clearly we may not, unless we are to adopt the unscientific conclusion to which the first calculation in this paper would lead us that exactly where the Milky Way is brightest there it is farthest away, and that its breadth increases in exactly the same proportion. The only apparent alternative is that the greater brilliancy of the Milky Way in parts of Cygnus and Scorpio, and in the great bright galactic clouds of the southern hemisphere, is due to a greater number of stars in a given volume.

Such evidence as it is amounts to (1) a general circularity of section; (2) a general equality of magnitude; and (3) an unequal distribution of the stars throughout the Milky Way. We can state, therefore, as at least an approximate truth, that the brightness of any part of the Milky Way is a measure of the relative number of its constituent stars, and, in a less degree, of its relative mass. Now the Milky Way in the southern hemisphere is of considerably greater brilliancy than it is in the northern hemisphere; or, to be more correct, the portion of the stream reaching from Cygnus through Aquilla to Argo, is brighter than the remaining portion, an arrangement followed, strangely enough, by the belt of great stars which intersects the Milky Way in Cygnus and Argo. It is in the southern hemisphere, then, that the matter of which the Milky Way is composed should be found in the greatest profusion.

The actual proof or disproof of this purely speculative result, however, can only be gradually evolved by years of work in the observatory. There are two chief difficulties to face: one the difference of texture, so to speak, between the northern Milky Way and the southern; the other, the possibility that the brightness of the galactic clouds may be due in part to local collections of clashing meteoric matter, though it must be admitted that meteoric matter is on the whole quite as likely to stop light as to send it. We can at any rate assert with some confidence that the brighter the region the greater the number of stellar points comprised within it, whether our instruments reveal them individually or not.

[Mr. Sutton leaves out of account brightness due to nebulosity between the stars.—A. C. Ranyard.]

*I assume here that the sun is not far from the centre of the galactic ring. The aspect of the Taurus-Orion belt of great stars seems to indicate that the true Milky Way stars are limited to telescope magnitudes. Nearly every bright star on the Milky Way appears to belong in some way to this belt, and the galaxy itself is rich in bright stars because it meets the belt at a very acute angle. This consideration eliminates the lucid stars from consideration here, and hence reduces the number of magnitudes we have to deal with. The exactitude with which the standard star represents the true average star is correspondingly increased.—J. R. Sutton.

CATERPILLARS.—II.

By E. A. Butler.

(*Continued from page* 206.)

CONTINUING the account of caterpillar structure which we commenced last month, we come to the three segments immediately behind the head. Each of these carries a pair of conical legs terminating in a sharp curved claw (Fig. 3). From their situation it is evident they correspond to the legs of the perfect insect, and that the three segments to which they are attached represent the thorax of the butterfly or moth, although there is here no definite line of division, as there would be in the perfect insect, to separate them from the rest of the body. These legs are of considerable use to the caterpillar, not only in walking, but also and more especially in holding the leaves while it is feeding. The blade of the leaf, being attacked at its edge, is steadied between the caterpillar's legs, while its head is stretched out to the full, and its mandibles, having been opened laterally, are brought with a sudden snap down upon the leaf edge lying between them. By this action a fragment is punched out as it were and immediately swallowed, while in far less time than it takes to describe the action, the head is bent round along the arc of a circle and a fresh snip taken as it is brought into each new position, so that in the end a curved excavation is made in the tissues of the leaf.

Fig. 3.—Leg of Caterpillar of Goat Moth, magnified 8 diameters.

Throughout the whole tribe of caterpillars there are scarcely any other organs that are so uniform in structure as these legs, and there is rarely anything exceptional about them, however varied may be the habits of the insect. But we have one species, the caterpillar of the lobster moth (*Stauropus fagi*), which deviates notably from this uniformity—a deviation sufficiently remarkable to lead us to suspect and look about for some adequate cause. In this rare and curious caterpillar two of the three pairs of legs are greatly elongated and, pointing forwards, sprawl out at the sides in a rather spider-like fashion; at the same time the front pair, which are not elongated, are widely opened somewhat as the jaws of a spider might be made to gape, and the hinder part of the body is bent up over the back, thus making some slight approximation to the shape of a spider's globose hind parts. Now as this is not the ordinary attitude of the caterpillar, but is only assumed when it is irritated, we may reasonably conclude that its assumption is intended as a means of defence, and it has therefore been supposed that this "terrifying attitude," as it is called, suggests to the creature's enemies a dangerous foe of the spider class and induces them not to molest it. It is true that the resemblance to a spider is far from perfect; in particular, the body is not so broad as a spider's would be, and there are only two pairs of legs extended instead of four; in fact, as Mr. Poulton, who has had good opportunities of watching this larva, admits, the "suggested monster" is "exactly like nothing upon earth, but is, nevertheless, most effective in its appeal to the imagination." At any rate, to an enemy gifted with some degree of imaginativeness, and approaching it in front, it would look sufficiently uncanny to suggest the idea of possible powers of harm-doing, and thus rouse feelings of suspicion and cause a would-be captor to hesitate before attacking it. Of course, if the enemy is shrewd enough to see through the deception, the fate of the larva is sealed, for it is in no way able to inflict injury or to protect itself

further, nor does it seem to be in the least degree an unpalatable morsel.

But as a few actual experiments are worth more than any amount of theorizing, we are fortunate in having records of the observed behaviour of this insect in situations of danger. Mr. Poulton placed one of them on a table and caused it to assume the terrifying attitude; he then drew the attention of a marmoset to it, but though this little monkey is very fond of caterpillars, and would seize with avidity those of an ordinary appearance, it hesitated for some time before proceeding to the attack, and when at last it summoned up sufficient courage, advanced in a very cautious manner. A lizard also manifested hesitation in a similar case, although, being a less intelligent animal, and therefore presumably less imaginative, it was not so strongly affected as the monkey. In this case the attitude was sufficiently influential to cause hesitation on the part of the marmoset, though it did not succeed in saving the insect's life. But possibly the result might have been different in the wild and open state of nature, where there would have been many other opportunities of obtaining food, and the preliminary reluctance might have developed into complete avoidance, and thus have been the means of preserving the caterpillar's life; and though no such foes as monkeys of any kind would encounter it in a native condition in this country, it is not improbable that birds, which would be its chief vertebrate enemies, might be daunted in the same way as the marmoset.

It has also been suggested that the spider-like attitude may be intended to frighten away ichneumon flies as well as vertebrate foes, not that parasites belonging to this group *never* attack spiders, but that they seem, as a rule, inclined to avoid them, and in fact they are very seldom found caught in spiders' webs. And further, it has been pointed out that the lobster moth caterpillar has a certain peculiarity of marking which would tend to protect it from ichneumons, even if they were not deterred by its fantastic appearance. On the first and second segments behind those to which the legs are attached, there is on each side a small pouch-like hollow of an intensely black colour, but capable of concealment by means of a triangular flap of skin. When the caterpillar is at rest, the black spots remain covered, but when irritated and alarmed the flap is drawn back and the black marks made to become conspicuous. Now, as ichneumon flies are apt to make small wounds on caterpillars, not only by their ovipositors, but also by their jaws and claws as they hold on trying to effect oviposition, and as the blood issuing from these wounds invariably forms a black clot, it is suggested that the appearance of these black spots on the lobster caterpillar may give the idea to an ichneumon contemplating attack that the insect has already been selected and has received the indwelling parasite, so that it is not available for the reception of another. It is much to be desired that experiments on this score could be tried with ichneumon flies, but for this we must be content to wait. Even with these beautiful adaptations, if they be such, we do not exhaust the means of defence possessed by this remarkable insect. Its brownish colour almost exactly resembles that of a dried and curled-up beech leaf, that being one of the trees on which it feeds, while in the time of its larval life, the late summer and autumn, such leaves would be likely to be about; and again, its long legs have been pointed out by Mr. Poulton, not only to be suggestive of spiders, but also, when folded up in the position of rest, to resemble very closely the little bunches of brown scales or stipules that hang down from the leaves of the beech tree. So this insect seems to be a special pet of Nature, the one frail child which is not fit to rough it, and to secure whose welfare, therefore, unusual precautions are required, its special need having led to the acquisition of quite special means of protection; and indeed, notwithstanding this, still it is not able to flourish and multiply to any great extent, for it is never other than a rare insect.

The six thoracic legs, as might be inferred from their form, are not the only, nor indeed the chief, means of progression possessed by caterpillars. Some of their hinder segments are furnished with pairs of fleshy and highly elastic pillar-like appendages, called claspers or prolegs, which are their chief, and sometimes their only means of support when they are on their food-plant. In all the larger species these organs have great grasping power, which is due to numbers of little hooks round their edge (Fig. 4), by aid of which the caterpillars can hold on so tightly that they will often endure damage rather than relax their grasp, the claspers themselves meanwhile remaining firm and tense by reason of the blood which is forced into them and kept there under pressure. The most common number of these equivalents of legs is five pairs, which gives the insect, together with the three pairs of thoracic legs, a total of sixteen points of contact with its base of support when at rest. One pair of prolegs is situated on the last segment; on the two segments in front of this, for a reason we shall see presently, there are none; and then the remaining four pairs occur on the next four segments; hence, remembering that there are in all twelve segments besides the head, it follows that between the last pair of true legs and the first pair of prolegs there are again two segments unprovided with appendages.

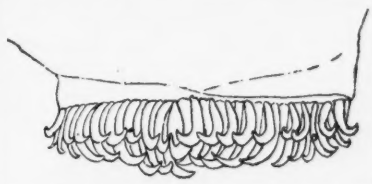


Fig. 4.—Microscopical preparation, showing hooks on proleg of Caterpillar of Lime Hawk Moth, magnified 16 diameters.

When a caterpillar thus equipped is resting stretched out at full length along a leaf or stem, it would generally hold on by all the sixteen legs; but some species rest clinging by the prolegs alone, the front part of the body being then elevated into the air. Special attitudes of rest are often characteristic of different groups. Thus, for instance, the caterpillars of several of the "hawk moths" elevate the front part of the body, and giving it a graceful curve, rest with it kept steadily, in a state of rigidity, in that one position, thus reminding one of the contour of an Egyptian sphinx. Amongst British insects this is best seen in the common privet hawk moth (*Sphinx ligustri*), which derives its generic name from the circumstance. After this caterpillar has reached its mid career, the sphinx-like attitude (Fig. 5) is often assumed as the ordinary position of rest, whence it would seem that some other reason should be sought for it than that of attempting to deter possible assailants, though conceivably the striking appearance of the caterpillar in this position might lead an animal which wished to make a meal of it to think twice before pouncing upon so stately

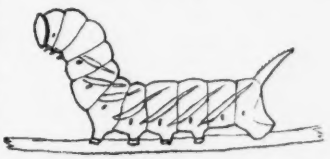


Fig. 5.—Caterpillar of Privet Hawk Moth, showing sphinx attitude, natural size (after Poulton).

and dignified a figure. Mr. Poulton indeed would reduce it to a mere question of mechanics. He points out that the attitude is only occasionally seen in the first two stages of the caterpillar's life, and that after that period it becomes much commoner, being most marked in the fourth stage, *i.e.*, the last but one. At this time the caterpillar usually rests upon the mid-rib of a leaf on its under surface, and later on, on upright stems, with its head towards the top of the stem. In either case, as soon as the front part of the body is released from contact with its support, it would naturally, by reason of gravitation, tend to fall backward, and the curved position would therefore result as a compromise between this tendency and the strain put upon its muscles in the attempt to neutralize the effect of gravity by becoming stiff and rigid. But though this explanation would no doubt account for much, it would not furnish any reason for the lifting of the body in the first instance, nor explain why the insect is not satisfied with doing as so many other caterpillars do, and indeed as it did itself when younger, namely, resting stretched out at full length on its support, and holding on by all sixteen legs. Amongst British insects we find some sixteen species of hawk moths, but they do not all assume the sphinx-like attitude, which is not marked in those that live in trees, while most of those that feed on low plants do not exhibit it.

When a sixteen-legged caterpillar, resting comfortably at full length, wants to begin to walk, it first advances the last pair of claspers, raising them and setting them down again nearer the last pair but one. This can easily be done, for it will be remembered that the two preceding segments have no legs, so that there is always a larger space between the last two pairs than between the others. Then, while it holds tight with this last pair, the others are successively raised from behind forwards, and planted firmly in the same order a step in advance, the legs of the opposite sides being, of course, moved together, and not alternately, as the perfect insect would do; at the same time a sort of wave of muscular movement travels along the body. The wave at last reaches the thoracic segments and the front part is thus moved on. The operation is repeated again and again with considerable rapidity, and thus the caterpillar manages to get over a good deal of ground in a short time, the actual pace depending, of course, to some extent upon the species.

Some caterpillars, such as those of the rare but beautiful Kentish glory (*Endromis versicolor*), and the moths called "prominents" (*Notodontidæ*), do not make much use of the last pair of claspers, and habitually rest with them lifted up and not adhering to any support. In other cases, they are not only unused but actually absent, and in their place we find a pair of stiff appendages forming a kind of tail, which is of no use for prehensile purposes. This is notably the case in the larva of the puss moth (*Dicranura vinula*). This extraordinary insect, which is scarcely less remarkable in form than the "lobster" itself, is a common species and may be found in the summer feeding on the leaves of willow and poplar trees. It throws the front part of its body into a somewhat sphinx-like attitude, and at the same time elevates the last three segments, which taper towards the tail and terminate in a pair of stiff tubular sheaths, prickly on the outside. From within each of these there can be shot forth rapidly a long, flexible, whip-like organ (Fig. 6) of a beautiful pink colour, cylindrical and hollow, but closed at the extremity. It is moved out and in much in the same way as the tentacles of a snail, that is, by a process of turning inside out and the reverse. The mechanism by which this is effected is twofold; it is extended by having blood forced into it, and as long as it remains full it retains its form and length, being at the same time capable of being flourished about like the lash of a whip; it is drawn back again by means of muscles which run up its tubular cavity, and are attached at its apex. The tip is first drawn in, and then, following it, more and more of the column, till the whole is withdrawn into the sheath. The action can be easily understood if one imagines the finger of a glove to be fully extended, and a thread to be passed up it inside and fastened to the top; on pulling gently at the thread, the tip descends into the hollow of the finger, and thus the whole finger, if the sides remain sufficiently firm, is gradually drawn back in a reversed position into itself and towards the palm, that surface which was at first an outward convexity now becoming an inward concavity. Of course, if means of exit were not provided for the blood contained in the whip-like filament, the muscular contraction would fail to withdraw it, as may be shown by tying a silken thread round its base when it is erected, so that the blood cannot return into the body, and then it will remain extended as long as the ligature is present.

Fig. 6.—Whip and sheath from tail of Caterpillar of Puss Moth, magnified 4 diameters (after Poulton).

Mr. Poulton has made very careful microscopical sections of this little organ, and has shown that it is most exquisitely constructed. The pink colour is due to a layer of thickish cells of spindle-shaped outline placed beneath the colourless outer layers of the skin. A little beneath this again lie bands of muscular fibres in the form of a hollow cylinder, and within this is a band of nerve fibres and a number of nerve cells, all the interspaces being filled with blood. The large comparative size of the nervous portion indicates the great sensitiveness of the organ, and accounts for the wonderful rapidity with which it can be moved. The whole organ in fact is extremely delicate, and slight damage done to it, especially at the point where it joins the tubular sheath, would entirely destroy the power of shooting it forth; this apparently is a misfortune that usually happens sooner or later, for the adult insect generally loses control over its filaments, and they may then be found lying helplessly within the sheaths. When, however, they are in good working order, the insect, as soon as it is touched, dashes its head round in the direction of the irritation and immediately shoots forth the tail filaments and flourishes them about; so that there can be little doubt that their purpose is to scare away ichneumon flies that may chance to alight upon its back. How great a need there is for this is evidenced by the fact that, notwithstanding this means of defence, a considerable proportion of the caterpillars perish through the attacks of a large reddish-yellow ichneumon; without this and other defences which they have, no doubt the mortality would be much greater. Like the puss moth, the "lobster" caterpillar also possesses no terminal claspers, but a pair of long rod-like appendages instead; but they are not hollow, and therefore possess no filaments. They help to heighten the effect of the "suggested monster" when the tail is turned forward and brought near the head, by becoming separated and thus simulating a pair of antennæ; but when the caterpillar is lying extended they are brought close together, and then simulate the stalk of the withered beech leaf which the caterpillar suggests. Other caterpillars belonging to the same group, those of the "hook-tips," so called from the hooked fore-wing of

XUM

WEST.

4th April, 1892.—Exposure, 1h.

6th April, 1892.—Exposure, 1h. 5m.

7th April, 1892.—Exposure, 50m.

N.

S.

PHOTOGRAPHS OF SWIFT'S COMET. Taken by Professor E. E. **BARNARD** at the Lick Observatory with a 6-inch camera of 31 inches focus.

Enlarged $2\frac{1}{4}$ diameters. Scale of this plate 1 inch = 1·2°. The Stars are represented by short lines parallel to the direction of the Comet's motion, as the camera was made to follow the motion of the Comet and not the diurnal motion of the Stars.

ed by Morgan & Kidd, Richmond.

XUM

the motion of the Comet and not the diurnal motion of the Stars.

ed by Morgan & Kidd, Richmond.

XUM

the moths, have the body terminating in a single point, while still others, the "prominents," have the usual pair of terminal claspers, but make no use of them, seeming as though they were gradually losing the power of doing so.

(To be continued.)

PHOTOGRAPHS OF SWIFT'S COMET.

By Prof. E. E. BARNARD, of the Lick Observatory.

THESE three photographs, selected from a series and enlarged $2\frac{1}{4}$ times, clearly show the remarkable changes the comet was subject to when near perihelion. A brief description of the pictures, pending a more detailed discussion, may not be out of place here.

These were made with the 6 in. Willard lens, strapped on to the tube of the $6\frac{1}{2}$ in. equatorial, which was used as a following telescope. The focus of the Willard lens is 31 inches. As the comet was moving rapidly among the stars, the clock-work, which corrects for the ordinary diurnal motion, would not serve to follow the comet. The nucleus was therefore brought to the intersection of cross wires, a high power eye-piece being used on the $6\frac{1}{2}$ in., and the telescope was constantly shifted by hand with the slow motion rods, so that the nucleus was always kept perfectly bisected, the clock simply correcting for the diurnal motion. The light of the comet seems to have been very strongly actinic, as will be seen from the amount of detail shown with comparatively short exposures, very little of which could be seen with the eye and telescope. Cloudy weather interfered greatly throughout the time of the comet's greatest brightness. After a long cloudy spell, I had examined the comet on April 3rd, when its tail was traceable for 20° with the naked eye. The 12 in. achromatic showed the tail, near the head, to consist of two thin streams of slightly divergent light, with scarcely any nebulosity between. There was certainly no third stream.

THE PHOTOGRAPHS.

April 4th, 15h. 30m.—16h. 30m. It will be seen in this picture that a third branch had made its appearance since the 3rd, in between the two previously seen. This central branch is shown in the photograph to be crested with a fine bright line, more or less curved and broken. For a short distance from the head a second line lies close by and parallel to it. To the north of the northern branch, there are one or two hair-like, dark spaces, which appear darker than the sky near; they are doubtless simple rifts in faint diffused nebulosity surrounding the comet. It will be seen that the tails of the comet readily break up into quite a number of separate branches at some distance from the head. The star trails, representing the direction and amount of motion of the comet during the exposure, are pear-shaped in this picture. This is due to the fact that the exposure was begun when the comet was near the horizon and the light of the stars was more or less absorbed by the dense atmosphere. This peculiarity serves to mark the beginning of the exposure and the direction of motion of the comet, the motion being in the direction of the large end of the trail.

April 6th, 15h. 35m.—16h. 40m. This picture shows the remarkable changes undergone by the comet in the short interval of two days. There is very little or no resemblance in the comet for the two dates. It will be seen that the separation in the tail makes a rather quick bend near the head. There are unequal bright areas in the main tail, some of which are suggestive of the remarkable changes seen in the picture for April 7th. There is a little incident connected with the history of this photograph of the 6th of April that may be of popular interest. On this date it was necessary for me to go to San José to fulfil an engagement to lecture that night (being one of a series of six lectures for the University extension). After the lecture, at 10h. 30m. p.m. I hired a horse and buggy and drove up the mountain, 27 miles, arriving at the observatory at 2.30 a.m., and between that time and dawn secured this photograph. On this date, to the naked eye, the tail was about 25° long, the head being equal to a star of the third magnitude.

April 7th, 15h. 45m.—16h. 35m. This photograph was made partly in moonlight and partly in dawn. I need scarcely call attention to the unique appearance of the tail on this occasion. There is still less resemblance to the former appearance of the comet in the short interval of twenty-four hours. A number of narrow branches are now shown in the tail near the head, the middle or main one of which has a curve in it some distance from the head. The most remarkable and unique phenomenon, however, is the apparent development of a secondary comet 2° behind the head in the main branch. There is at this point a great enlargement or swelling, which is gradually brighter in the middle, and from which a new system of tails seems to branch out. A photograph made the next morning in full moonlight showed only a portion of the tail close to the head, the sky being too bright for the photography of faint objects. The scale of these enlargements is 1 inch = 1·2°.

It seems to me that these photographs are a revelation to us. We are familiar with the rapid changes that comets sometimes undergo, but if these three pictures, so close together in point of time, had been drawn by the most competent observer, most astronomers would probably have attributed their remarkable differences to the unskilful hand of the artist, for there is absolutely no resemblance among them. The accuracy of the photographic plate, however, is unquestionable, and these pictures therefore give us an insight into the rapidity and vastness of cometary changes little dreamed of before.

In examining this series of photographs the idea has been very forcibly impressed upon me that there was possibly, in the case of this comet, a rotation of the tail upon an axis through the nucleus, in a comparatively short period. It is to be regretted that cloudy weather broke the series to such an extent that it is not possible to settle this question; still it is a point that must be closely looked after in our next large comet.

Mount Hamilton, August 31st, 1892.

ON THE FORMS OF COMETS' TAILS.

By A. C. RANYARD.

THE beautiful photographs, for which we have to thank Prof. Barnard, show some remarkable irregularities in the streams of matter driven away from the nucleus and from the sun. There is not merely a variation in the brightness or density of different parts of the tail, such as might be caused by the matter being driven away from the nucleus in varying quantities at successive instants, but the edges of some of the streamers appear to be distinctly curved or bent in an irregular manner. This is particularly noticeable in the southern edge of the great streamer, photographed on the 6th of April.

We do not know how far the photographic record obtained may be affected by the motion of the matter of the tail during the 65 minutes for which the photographic

XUM

plate was exposed, but any motion of a bright mass of matter in the tail in a direction away from the comet's head during the exposure would tend to obliterate such irregularities, and give a straighter appearance to the streamers or jets.

There can be no doubt about the existence of the irregularities referred to. The southern (or right hand) edge of the great streamer, photographed on the 6th of April, is very distinctly notched or bent inwards at a distance of about 4° (that is, at a distance of about $3\frac{1}{2}$ inches on the scale of our plate) from the nucleus. A little above the notch the narrow stream of luminous matter which forms the southern edge of the great streamer divides into two, or forks. This is clearly shown in our plate at a distance of about 5 inches from the nucleus, and it is still more clearly shown on the glass enlargement from the original negative which Prof. Barnard has kindly sent to me. There is also just traceable on the plate, and distinctly visible on the glass enlargement, a narrow stream on the inner or northern side of this branching structure, and several faint structures which appear to branch or fork somewhat after the manner of the structure on the edge of the great streamer.

There is also a distinct bend in the edge of the great streamer of the 6th of April nearer the nucleus at the place where it divides from the fainter group of rays which form the southern half of the comet's tail. The division between the great streamer which forms the northern half of the tail and the group of rays which forms the southern half is continued as a very narrow black line towards the nucleus, and this line makes a very obtuse angle with the rest of the southern edge of the great streamer. On the northern side of this narrow dark line is a bright forked structure, the branches of which trend away from the nucleus, similarly to the branches of the forked structure referred to above.

The branching structure last described has, as shown on Prof. Barnard's glass enlargement, a form which reminds one of a solar prominence, and it gives a clue which may possibly explain the irregularities in the edges of the streamers. If during the rapid evolution of vapours in the neighbourhood of the nucleus, gas is evolved in irregular or intermittent quantities, and is projected outwards, we should expect an uprushing mass of gas in passing through a resisting medium or atmosphere about the cometary nucleus to take the tree-like prominence forms which uprushing masses of gas take upon the sun, and such prominence forms, as they are driven away from the sun and nucleus, would give rise to irregularities in the edges of the streamers as well as to the mottled appearance of the tail which we see in Prof. Barnard's photographs.

In a waterfall the foam on the surface tends to arrange itself into parabola-like curves with the apex downwards, because the stream is retarded at its edges, and a wave on the surface or any other line across the stream moves more rapidly at the centre than at the edges of the stream, but there are no such transverse markings in the mottling of the tail of Swift's Comet. The mottling seems to be disposed in irregular masses, with here and there an appearance of branching in a direction away from the nucleus. Such irregularities are worthy of the closest study, because deviations from general laws have always formed stepping-stones to further discovery.

Our first step is to make sure of facts. There can be little doubt that there is a decided bend in the lower part of the main stream photographed on the 7th of April, about half-way between the nucleus and the curious knot or branch in the main streamer, which Prof. Barnard describes as a second comet; possibly it may have been a secondary or attendant comet, seen through the tail of the large one, for such attendant comets have been observed before, though, as far as I am aware, they have not appeared in the midst of the tail of a large comet and, apparently, intimately associated with one of its streamers. The fact which chiefly weighs with me in concluding that the structure was probably a second comet is that the bright point which seems to form the nucleus of the little comet is not stretched out into a line by the motion of the camera in following the large comet—as all the stars are. The nucleus of the little comet was therefore a bright point which was moving with the large comet. But the rest of the small cometary structure has very much the appearance of being an irregular branch from the main streamer of the large comet.

It is much to be regretted that we have not other photographs taken an hour or two before and an hour or two after Prof. Barnard's photograph on the 7th of April, and it would also have greatly added to the interest of his work if Prof. Barnard had taken photographs of the comet with short exposures of a few minutes before and after the long exposures. We should then, no doubt, have been able to trace more structure in the head or nucleus of the comet, which is now obliterated by the long exposure. But Prof. Barnard did not expect to find the light of the comet so actinic. Curious irregularities have been noticed in the tails of other comets, notably in the tail of the great comet of 1882. There is a curious increase of brightness and striation towards the end of its tail, which was drawn by more than one observer and was photographed on October 20th at the Cape Observatory. The original negatives of this comet have been deposited by Dr. Gill in the library of the Astronomical Society at Burlington House, and are well worthy of examination.

There is evidence which can hardly be doubted tending to show that the tail of Donati's great comet, which appeared in 1858, did not lie accurately in the plane of its orbit. According to Prof. G. P. Bond, who collated the drawings and observations of a great number of European and American observers of this comet, and discussed them in a very valuable monograph which was published as Vol. III. of the "Harvard Annals," the axis of the tail of the comet was inclined at an angle of nearly 4° to the plane of its orbit; and during nearly the whole of its apparition there was a contrast in the density of the two branches of the tail, which remained unchanged when the earth passed through the plane of the comet's orbit on the 8th of September—a fact which points to the conclusion that there was no revolution about an axis, of the nucleus, or swarm of stones, from which the streams of matter forming the tail issued.

The curvature of the tail or tails (for Donati's comet had three), as well as the gradual decrease of density of the tail with increase of distance from the nucleus, points to the conclusion that matter is continually streaming away from the nucleus, and is driven away from the sun. Matter driven backwards into space with very great velocity, compared with the velocity of the nucleus in its orbit, would evidently form a nearly straight tail in the prolongation of the radius vector (or line joining the nucleus with the sun), while matter driven backwards with a velocity comparable with the velocity of the nucleus would drop behind the radius vector, and form a tail curving backwards in the plane of the orbit, the curvature being more and more apparent the slower the velocity with which the matter of the tail was driven away. Thus the different curvatures of the tails of comets exhibiting more than one tail is accounted for.

Prof. Bredichin, whose theory has been much quoted, is inclined to call in an unknown electrical repulsion,

differing for different materials, to account for the different velocities of repulsion, and the different curvatures of cometary tails.

The particles of which comets' tails are composed are evidently very small, for they are small in average diameter compared with the wave-length of light—this is rendered evident by the fact that the light dispersed of comets' tails (except in the neighbourhood of the nucleus, where a gaseous spectrum is recognizable) is generally strongly polarized—and it seems to me that we may satisfactorily account for the repulsion of such small particles from the sun without calling to our aid any unknown force, but by merely considering the repulsion which would be caused by evaporation taking place from the side of the particles exposed towards the sun. In a paper published in KNOWLEDGE for February 16th, 1883, I have discussed the accumulated effect of the minute recoils which must accompany evaporation as one molecule after another is thrown off from the surface of a small heated body towards the sun. When three-fourths of a heated particle have been thus evaporated towards the sun, the velocity of the remaining one-fourth away from the sun would be greater than the molecular velocity of evaporation, but the irregularities in the tails of comets referred to above show that we have other forces to consider, which slightly vary the form that cometary tails would assume if the matter of the tail were only acted upon by repulsive forces, in directions away from the sun and away from the nucleus.

Science Notes.

Part XIII. of "The Old and New Astronomy," containing the last portion of the chapter on the Stellar Universe, with the title page, preface, and index, is now in the hands of the public.

Fresh applications of photography are continually being reported. The camera has revealed much with regard to animal locomotion; the nature of the horse's movements in trotting and galloping have been revealed, much to the surprise of many animal artists. So with regard to the movements of birds' wings, which have been photographically registered. But photography has recently been applied to record the movements of the growing parts of plants, and some curious results have been obtained. In the case of the hop-convolvulus, the movement of the young stems consists of a succession of irregular, circular, or elliptical curves, which vary every moment, even in their direction. These movements are caused by unequal growth in different parts of the stem. Even when asleep, plants move, not, as was formerly supposed, interruptedly, but continuously.

The apple-rot is produced by a parasitic fungus, which appears to be the same as that which causes the ripe-rot in grapes. The disease is infectious, as anyone who keeps a number of apples may observe; for it is passed on from one apple to another. But if those who gather the apples, and pack them for market, were a little more careful in handling them, we should not have so many affected. Any slight bruise on the skin is sufficient to cause those disagreeable brown spots which cannot be eaten.

In a recent number of *Nature*, Mr. H. H. Dixon describes the walking of certain insects (*Arthropoda*) as revealed by photography. The paper is most interesting.

Congress has this year refused, for the present, to sanction any further expenditure on the United States Geological Survey. Field work has been suspended, but it is to be hoped that the survey will not come to an end, for such an event would be little short of a catastrophe. English geologists have learned a great deal from the splendid monographs and bulletins that have been so generously supplied to our libraries and museums, and all must admire the ability and thoroughness with which most of the work has been done. America is such a huge country, and contains such magnificent illustrations of physical features produced on a great scale by denudation, volcanic action, earth-movements, &c., that it would be a great pity if no further geological surveying were undertaken. It is well known, however, that certain abuses have been going on, and, if these can be removed, probably this important work will some day be renewed.

An interesting discovery is reported in the November number of the *Mediterranean Naturalist* by Mr. J. H. Cooke, namely, the finding of a portion of an Arctic bear's jaw (*Ursus arctos*) in pleistocene strata, Malta. It had previously been concluded, from the fact that elephants' bones discovered there were much gnawed, that there must have been carnivorous animals living there at that period, but no remains of such could be found. Now Mr. Cooke has carried out some excavations in the Har Dalam cavern, and found the evidence that was wanted, viz., an entire *ramus* of the lower jaw of a bear with its canine molars. Besides the bones of elephants, those of the hippopotamus, stag and a large dog were found.

A new genus and species of blind cave salamander is reported by Mr. L. Stejnger in the "Proceedings of the United States National Museum." The discovery of such an animal in North America is regarded by the writer as a most important and interesting event.

Science contains an interesting paper on the food of humming-birds by Dr. Morris Gibbs. Although he has dissected many specimens, he found no evidence that they lived on insects. Possibly, when flowers are scarce some species of insects may be taken, but when flowers are abundant the ruby-throat of Michigan lives on honey.

The important work by Mr. Saville Kent, on "The Great Barrier Reef of Australia," announced by Messrs. W. H. Allen & Co., is a book to which naturalists are looking forward with considerable interest. Geologists will also be interested in it, both on account of the problems connected with Darwin's theory of coral-reefs (now abandoned by Mr. Murray and others), and because there are fossil reefs—probably of the same nature—buried in several well-known English formations, viz., the silurian, devonian and carboniferous, and the jurassic series. But for some reason or other the biological aspects of coral-reefs have been somewhat neglected, although their pools and lagoons are full of varied forms of life. The author, who is fishery inspector of several of the Australian Colonies, is a recognized authority on lower forms of life, such as infusoria, sponges, and corals. The book will be illustrated by 16 coloured quarto plates and 48 photographs. The former have been copied from paintings from nature by the author. The photographs show large areas exposed at low tide, and some submerged parts of reefs.

A very wonderful new "extinct monster" has recently been set up in the Natural History Museum, Cromwell Road. It is to be seen in a handsome glass case at the end of the fossil reptile gallery, among the ichthyosauri and other extinct types. This fine specimen, the only complete skeleton known, was discovered last year by Professor H. G. Seeley, in South Africa, and has been

XUM

described by him in a paper read before the Royal Society in 1891. In length it is nearly eight feet. The bones are all massive and strong, its legs are short, and when walking the creature probably had a somewhat sprawling gait, like a crocodile or lizard. The head is much like that of a salamander, or even a frog. It is difficult to say what the animal was most like, but it probably was amphibious. Altogether it is a strange and now wholly extinct type, with a resemblance to a salamander, and yet in some ways aping a modern mammal. The name *Pariasaurus Baini* has been given to this remarkable reptile, and it was found in the Karoo formation (probably of triassic age), near Tamboer Fontein.

More than twenty years ago Mr. Alfred Russell Wallace told the Zoological Society of a so-called "horned toad," which was said to squirt blood from its eyes. The information was derived from a correspondent in California, and probably, at the time, many who heard the news were disinclined to believe in it. But lately the matter has been confirmed beyond all doubt. Mr. O. P. Hay records, in the "Proceedings of the United States Museum," that two boys from Texas showed him some lizards belonging to the genus *Phrynosoma* (popularly known as "horned toads," and distinguished by a remarkable frill round the neck). These, the boys declared, would sometimes, when teased, squirt blood out of their eyes. At the time he was incredulous, but lately he has proved that the boys were right. A living specimen of this lizard, sent from California, was in the museum near his desk. About August 1st it was shedding its outer skin, and as the process seemed a somewhat difficult one on account of the dryness of the skin, he proceeded to give the animal a wetting. For this purpose he took it up and tossed it into a basin of water. To his great surprise, there suddenly appeared on one side of the basin a number of spots of red fluid resembling blood. By means of a microscope this fluid was proved to be blood, and on another occasion Mr. Hay was able to observe that the blood came directly out of the right eye. Truly, there is no end to the possibilities of Nature.

The late Poet Laureate was one of the few poets who introduced into his works the results of modern science, and clothed them in poetic form. He thus not only showed his sympathy with the age, but set a good example to others by indicating that the love of Nature should go with a desire to understand her workings, and the laws by which all things are governed. Science, rightly considered, is full of romance, and many a scientific truth might, if expressed poetically, be found quite as fascinating as some old-fashioned romances and fairy tales. The familiar saying, "Truth is stranger than fiction," is often on our lips, but few seem to act upon this truth by endeavouring to bring out the poetic aspects of science. Geology teaches us that the former history of our earth is, as it were, a great drama. To the geologist the world is a stage on which the various scenes in this great earth-drama have been enacted. The players were the pre-Adamite animals whose remains we discover embedded in the rocks beneath our feet; while old-world forms of vegetation gave beauty and completeness to the scenery. Then there is the romance of Astronomy, which appeals very forcibly to some people. But every science has its romance, from Chemistry, with its ever-dancing molecules, to Biology with its wonder-working protoplasm—the basis of all life.

Lovers of Tennyson will easily recall certain passages in his writings in which scientific discoveries (and sometimes theories) are introduced like precious stones set in the gold of verse. The following examples occur to us, but doubtless our lovers of Tennyson will recall many others. In "Locksley Hall," a lovely description of the Pleiades is followed by two lines referring to the untold æons revealed by Geology:—

> "Here about the beach I wandered, nursing a youth sublime
> With the fairy tales of science, and the long results of time."

Geological truths are again referred to in "In Memoriam." The following lines refer to former geographical revolutions:—

> "There rolls the deep where grew the tree,
> O earth, what changes hast thou seen!
> There, where the long street roars, hath been
> The stillness of the central sea."

There is no doubt at all that land and water have in many parts of the earth over and over again changed places, and large tracts once under the sea have been raised up into dry land; as, for example, the chalk round London. This formation must have been slowly formed in a fairly deep sea, say of 2000 to 2500 fathoms. But the latest researches indicate that probably the very deepest parts of oceans have never been dry lands, so that the expression "the central sea" is not quite in harmony with modern teaching. But with this slight qualification the geology here introduced is quite correct.

No exception, however, can be taken to the next verse, in which the great work of "denudation" is beautifully expressed. Geologists know that great mountain ranges have, in the course of ages, been worn down by "rain and rivers" until nothing but a mere wreck of their former grandeur is left. Tennyson thus expressed this important truth:—

> "The hills are shadows, and they flow
> From form to form, and nothing stands;
> They melt like mists, the solid lands,
> Like clouds they shape themselves and go."

In "The Princess" are to be found several allusions to Geology, Astronomy, Electricity, &c.

RECENT TRADE AND THE NATION'S DRINKING HABITS.

By ALEX. B. MACDOWALL, M.A.

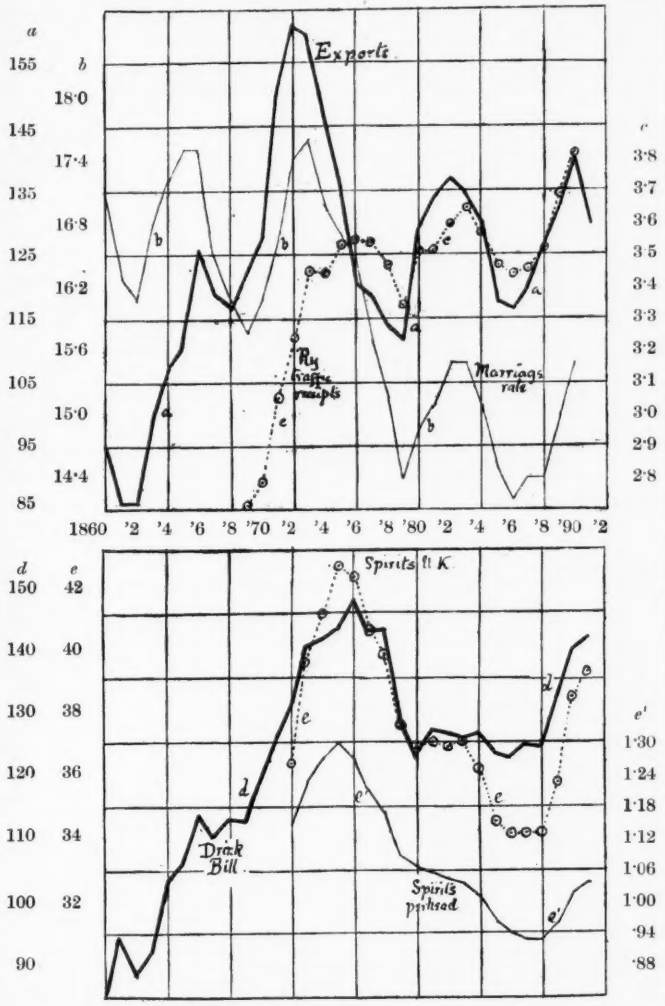
WE have long been used to hear a great deal about depression of trade and bad times. Some seem to think depression is the chronic state of trade, yet while it may be said, in general, that trade has been depressed for many years past, one may note certain well-marked fluctuations in the last twenty years; trade becoming more brisk for a few years, then less brisk again. Let us try to form a clear idea of those waves by means of curves.

The method of curves is now well known, and we need not stop to explain it. While the curves here given are all comparable together, the comparison must not be pushed too far; for while they have all the same time scale (the horizontal one), they have each a different vertical scale (indicated by letters *a*, *b*, *c*, &c.). Thus one may superpose (so to speak) several diagrams, economizing space. In these curves attention is especially asked to the waves, and the times of their high and low points.

How shall we measure trade? Our exports afford a very fair measure. We take, then, the values of exports of British and Irish produce per head of population (and in shillings) since 1860, and thus obtain the curve marked *a*. This rises rapidly, with a small crest in 1866, to a very high crest in 1872; then goes down to 1879; up again to 1882; down to 1886; up to 1890; and last year it again goes down. We are now on the descending slope. The time of that high maximum will be remembered by many, when our commerce rose (as Mr. Gladstone put it) by leaps

and bounds. It was about 1874 that the depression set in from which we have suffered more or less since.

A good reflection of the state of trade is offered by the marriage rate. Naturally, when money is plentiful, more people marry; when scarce, fewer. Here (*b*) is the marriage rate curve for England and Wales. Its waves correspond very well with those in the curve of exports. There was a great fall in the rate from that very



prosperous time, and the rate has not since recovered its previous position.

Look at the matter in another light—(curve *c*), that of the railway traffic receipts per mile of railway (the unit here is a thousand pounds). The story is similar. Notice, however, that we have the first wave culminating in 1876, four years later than the great wave of exports.

The exports curve does not enlighten us much as to general increase or decrease of our trade, for this reason, that it is a curve of values, and there has been a great fall in prices since the seventies. Curves of volume would be more instructive in this respect.

It is interesting to notice the intervals between the wave-crests. They are, in this period, about eight or nine years; taking the dates of the marriage rate curve, we have 1865 to 1873 (eight years), 1882 (nine years), then, say, 1890 (eight years). Should this recurrence continue, we should expect a crest about 1898 or 1899, and the bottom of the trough, into which we are now descending, a year or two from the present. The causes of trade depression have, of course, been much discussed; over-production, protection abroad, bad harvests, disturbances of the currency, are some of the causes that have been suggested. But we will not here enter into this question.

It is well known that our national consumption of alcoholic liquors depends very much on whether trade is good or bad. Good times of trade are bad times of drinking, as a rule. Here is a curve (*d*) which shows our drink bill since 1860 (in million pounds). It rises rapidly to 1876 (when railway traffic receipts were at a wave-crest), after which comes a fall. The next trade wave is but slightly represented, but since 1886 there has been a pronounced rise corresponding to the trade wave which culminated in 1890.

A curve (*e*) of spirits (British and foreign) retained for home consumption in the United Kingdom shows very much the same thing. (This refers to potable spirits alone from 1877, and to millions of gallons.) Another curve (*e'*) shows the spirits per head of population (in gallons). Both of these culminate in 1875.

Now it is often urged, somewhat confidently, that an increase of consumption of spirits, or of the drink bill, is no proof of an increase of *excessive* drinking; people are merely consuming more in a moderate way, it is said, in accordance with their easier means. It is a significant fact, however, which we meet on turning to the subject of apprehensions for drunkenness (of which we give a diagram), that we find waves in these closely corresponding to the waves of trade. Here, for example (curve *f*) is a curve showing (in thousands) the total apprehensions for this offence in England and Wales since 1871. It has a wave-crest in 1876, then in 1884 (a little after the trade wave-crest), and ends at, or near, another crest. Again, look at the three curves *g*, *h*, *i*, which relate to *convictions* for drunkenness in three great police divisions of England and Wales; we again find correspondence. The curve *j* (once more) shows apprehensions in London. We may note that it continues rising some time after the culmination of the very prosperous time to 1878, and that the next wave is hardly represented in it.

The general question as to whether drunkenness is increasing or otherwise is a difficult one. Taking only short periods, one may easily make mistakes. Thus, in 1880, a person might say, "What a vast improvement lately!" and in 1890 or 1891 it might be said, "How terribly we are deteriorating!" These would be but half truths.

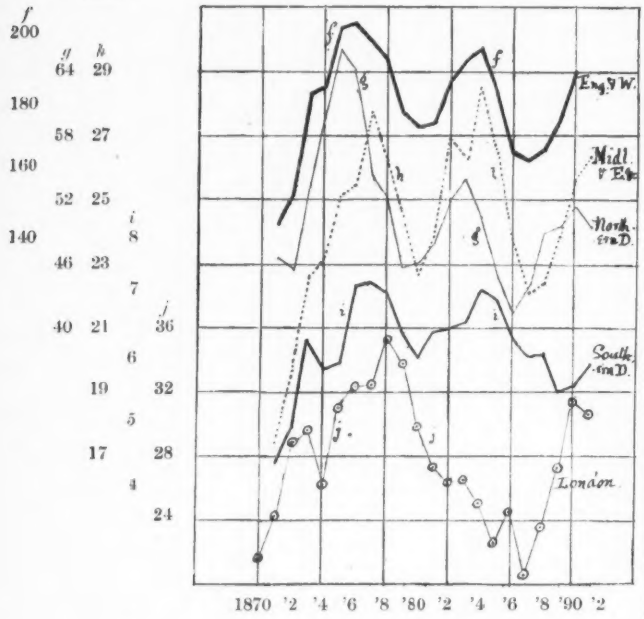
The curves of drunkenness here given appear plainly to mean some improvement in the period considered. For they all either keep about a level, or tend to go down, and we have to remember that the population has increased; so that unless we are to make the unlikely supposition of a general increasing laxity in apprehension, there are fewer people, proportionately, who transgress and attract the attention of the police.

On the other hand, if we measure drunkenness by the consumption of spirits in a long period of years (say fifty), we find the curve swaying now to the one side, now to the other, yet, on the whole, departing in no continual way from the curve of population (or from the proportion of one gallon per head).

If some improvement is perceptible, it cannot be said that the great tide of intemperance is being effectively stayed. Should another time of good trade come like that before 1872, dare we expect that our drink curves would

XUM

not mount as much proportionally as they did at that time?



Convictions and Apprehensions for Drunkenness.

The great rise of public sentiment in favour of temperance is a remarkable feature of our time; and if with so many of our best citizens strenuously at work contending with this national vice, the evil still continues so bad, we have thankfully to remember how much worse it would have been if these efforts had been withheld.

These diagrams (in the present writer's opinion) afford an easy means of testing statements of various kinds which are made on the great drink question.

Notices of Books.

Théorie du Soleil. Par A. Brester, Jz. Amsterdam, 1892.—There can be no doubt that the physical constitution of the sun still remains to a large extent enigmatical. Experience is, indeed, baffled by the intensity and scale of action of the forces concerned, and the extension of inferences beyond the sphere where they are certainly legitimate to far outlying regions is always a perilous process. The subject hence bristles with difficulties which, in many cases, seem to become more formidable the more closely they are examined. Efforts to remove them, individually and collectively, are continually renewed, not altogether fruitlessly, though with only partial success. The work before us aims at providing a complete solution of the entire problem. It is evidently the outcome of long thinking based on painstaking research, and as such deserves respectful consideration. Yet we doubt whether Dr. Brester has really found the *mot de l'énigme*. His theory is essentially a chemical one. Stars and suns, as he says, "being after all nothing but enormous bubbles of incandescent gas, and incandescent gases being precisely the substances with which modern chemistry is best acquainted, it seemed to me that in studying such bodies chemical science should, in the first place, be consulted. If these vast bubbles are composed of matter in the last stage of disaggregation—of matter, that is to say, evaporated, dissociated, and dilated by transcendent heat—it belongs to chemistry to predict the course of change in this attenuated matter as it radiates away its heat."

Starting from this postulate, Dr. Brester contrives to "save" (as the old Greeks used to phrase it) all the solar phenomena. His sun, he truly remarks, is like the suns of most other theorists, only it behaves in a totally different manner. Assuming the absence of external causes of agitation, he concludes the workings of the great machine to be carried on in almost absolute physical tranquillity. Neither cyclones nor eruptions (in the material sense) occur in his sun; uprushes and downrushes are alike absent; the stratification, in the order of their densities, of the vapours forming the solar photosphere, subsists perennially undisturbed. To account for the apparently violent commotions observed in the solar atmosphere and its surroundings, the dissociating power of heat and the effects of chemical affinity are alone invoked. The progress of refrigeration, it is argued, incessantly brings about partial combinations of the most elementary principles of matter, and this being accompanied by the development of heat, dissociation again ensues, and so the play of forces is kept up. Their play, moreover, is rendered more or less spasmodic by the prevalence of what our author terms "superdissociation." This state is reached by atoms cooled down below the point at which their strong inherent affinities would bring about their combination were it not for the copious presence of atoms of different natures, and when they are eventually enabled to come together it is in such numbers, and with so great violence, as to cause a "heat eruption." Such heat eruptions, by dissolving the photospheric clouds, occasion spots, while the coronal rays, as well as "white prominences," mark regions where a lowering of temperature has permitted the formation of a glowing mist capable of reflecting sunlight. Thus, no transport worth mentioning of ponderable matter is involved even in the most seemingly tumultuous of the solar crises. Calm really prevails in strata through which hurricanes appear to sweep. Prominences, accordingly, are maintained to be mere evanescent illuminations. They are the products of rapidly propagated chemical action. But if this were the case they would give a continuous spectrum. Hydrogen ignited by combustion shows no trace of its characteristic rays. Moreover, the rate of propagation of chemical action through a gaseous mass is vastly too slow to account for the line displacements in prominence-spectra, usually admitted to be due to motion in the line of sight.

Dr. Brester's elaborate discussion, none the less, raises several valid objections to current theories, and insists upon incongruities too apt to be lightly passed over. It serves, at the least, a useful ventilating purpose. Copious annotations, too, in the shape of foot-notes afford in themselves a very fair conspectus of the literature of the subject, and add greatly to the value of the book. It is, indeed, only the first instalment of a larger work, the second and third parts of which will apply the principles now unfolded to elucidate the natures of stars, nebulæ, and comets. They were employed to explain stellar variability in an essay published in 1889, but that intricate theme cannot here be entered upon. Agnes M. Clerke.

Vegetable Wasps and Plant Worms. By Dr. M. C. Cooke (Christian Knowledge Society).—Under this somewhat romantic heading Dr. Cooke, the well-known authority on cryptogamic plant life, gives what is described in the subsidiary title as "a popular history of entomogenous fungi, or fungi parasitic upon insects." The book is essentially a compilation which has been made in the interests of two classes of readers, mycologists and entomologists, to both

of whom it should be welcome as summarizing present knowledge and indicating the advantage, and indeed necessity, of co-operation between students in different branches of science. Much loss has hitherto accrued to science in consequence of the lack of such co-operation. The entomologist, it is true, describes and identifies his insect accurately enough, but when he comes to the fungus which has spoilt his specimen he has nothing but loose and vague terms for it, and fails to hit upon its characteristic features, so that the mycologist cannot recognize the systematic position of the plant from his description; and on the other hand, the botanist, while careful enough in working out the life-history of his fungus, is too apt, through lack of interest, to go astray in his entomology, and fails to identify his insect, or even sometimes does not so much as determine the order to which it belongs. Such a book as this ought to do much to remedy this defect, showing as it does the imperfection of much existing knowledge, and indicating the gaps which only co-operation can fill up. In the body of the work the claims of the student of insect life seem at first sight to be most prominently recognized, the hosts which suffer from fungoid parasites being treated under their respective orders systematically; further on is added, for the special benefit of the lover of these lowly plants, a classified list of the fungi, including a mention of their several hosts. To the majority of readers it will no doubt be news that there exists material enough for the compilation of a substantial volume of three hundred and fifty pages on such a subject as this. Few persons except specialists are acquainted with more than two or three kinds of parasitic fungi. There is first the minute form that is so destructive to house-flies, gluing their bodies to the window panes, walls, or chandeliers, while it surrounds the corpses with a sort of whitish halo. Most good museums, again, contain specimens of certain New Zealand or Tasmanian caterpillars from whose bodies project a long horn-like fungus sometimes to the length of several inches. Then there is the species which has earned notoriety by the extent to which it has touched the pockets of a certain section of the commercial world, viz., the celebrated muscardine, which for many years created immense mortality amongst silkworms. But when we have enumerated these we have probably almost reached the limits of popular knowledge; yet Dr. Cooke enumerates some two hundred species which have already been described as preying upon insects and spiders of different kinds, and this he is able to do without entering at all, except to the extent of the single species that causes the so-called "foul brood" amongst bees, upon the broad field of investigation connected with the minute bacilli and bacteria, which play so important a part in respect of the well-being of both animal and vegetable life. Parasitic fungi attack insects in very different ways. Of course a dead insect will be subject, like all other organic matter, to the growth of moulds, which would probably be of the same species as those that appear on other corpses. But it would be hardly justifiable to call these parasitic, and therefore it is specially with those that attack living insects that our author is concerned. Here the fungus may merely use the insect as a basis of support and be simply attached to its exterior, thus apparently doing little harm; or it may become a much more insidious enemy by penetrating the body, forming its vegetative portion or *mycelium* at the expense of the tissues of its host, and ultimately bursting through the skin for the formation of its reproductive portion externally. Much depends upon the habits of the insect; those that live in close or damp situations, beneath the ground, or in burrows in trees, are more liable to attack than those that lead an exposed life. The maturation of the fungus, Dr. Cooke maintains, does not take place till all the interior of the host has been absorbed, and it has therefore succumbed. It is only in this condition, when the spore-bearing receptacles have been developed, that the characteristic features of the fungus are exhibited, and its specific determination becomes possible. Before suffering its fate, the insect, as it finds its end approaching, often climbs into some conspicuous position, clinging with a death-grip to a leaf or stem of grass; while it remains in this attitude, the fungus passes through its skin, and by its own growing threads attaches the corpse firmly to the substratum on which it rests, while the spores, when developed, find themselves in a suitable position for being conveyed away by the wind to do destruction elsewhere. Dr. Cooke figures various kinds of ants, bees, wasps, beetles, and other insects that have thus become the soil out of which grow branching threads or club-headed columns, by which, in some cases, the appearance of the insect is so greatly modified as to have given rise to the name "Vegetable Wasps." The perusal of this book will serve to impress vividly upon the mind that the dangers to which insects are exposed during their life by no means all arise from the animal world, but that the vegetable kingdom supplies foes quite as insidious and quite as deadly as any that arise from other sources.

Beetles, Butterflies, Moths, and other Insects. By A. W. Kappel and W. E. Kirby (Cassell & Co.).—The authors have catered for beginners in entomology, and for those who, while not professing to be students of the science, yet like to know something about the common insects to which a visit to the country introduces them. They have produced a book of reference which, while it makes no great demands upon either the purse or the time, gives the sort of information such readers require, as to structure, habits, collection and preservation. Between four hundred and five hundred selected representatives of the seven principal orders are briefly described, those, as a rule, being chosen, and wisely so, which are either the commonest or have some special point of interest in their economy. An analytical table for determining the order to which an insect belongs is a useful feature which will be much appreciated by beginners, who are often puzzled as to the nature of their captures. About one hundred and seventy species are figured in twelve coloured plates, which are generally well executed, though with a little tendency to gaudiness, and in our opinion the tinted ground on which they are printed is hardly an improvement.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

ON THE IMPERFECTION OF OUR KNOWLEDGE OF THE SPECIES OF INSECTS.

To the Editor of KNOWLEDGE.

DEAR SIR,—Few persons, even among entomologists, have any idea of the vast numbers of insects which exist, or of the immense gaps in our knowledge of even the largest and most conspicuous groups. In the introduction to the new edition of my "Elementary Textbook of Entomology" I have estimated the number of species already described at 270,000, and the actual number of existing species is variously guessed at by different authors at from two to ten millions. Even at the former figure, which I must admit appears to me far too low, it was calculated by Lord Walsingham, in his notable address to the Entomological Society of London, in January, 1890,

that, at the rate of 5800 descriptions of new species per annum, it would require 340 years merely to describe all the undescribed species of insects; and the description of a species is only the beginning of our knowledge of the insect itself in its perfect state. Every species would require many volumes before its life-history, habits, anatomy, physiology, and relations to other species could be dealt with, with anything like completeness. All that any entomologist can accomplish is to add what he can to the gradually accumulating stores of knowledge in the special department of entomology to which he is best able to devote himself by study and inclination.

In England we have about 12,000 species of insects, and it is perhaps not to be expected that the ultimate total, when all the smallest species have been collected and studied as assiduously as the larger ones, will exceed this estimate by more than a few hundred, or at most one or two thousand. But with foreign countries it is very different; and I must confess that I was surprised, when I lately received a fine new species of *Phasmida*, from Madagascar, to find that barely half-a-dozen species had yet been recorded from that island. And yet the *Phasmida*, or stick insects, are among the largest insects. They are generally conspicuous, and easily collected, and Madagascar is an island from which large collections of insects have repeatedly been received of late years; and yet our knowledge of this group of insects as occurring in the island is practically *nil!* If this is the state of our knowledge of such insects as *Phasmida*, how imperfect must it be of the smaller species of *Coleoptera*, *Hymenoptera*, *Diptera*, &c., many of which are of almost microscopic dimensions! Many insects are so local and so closely connected with plants which disappear before civilization, that the same fate of extermination which has fallen on so many of the larger animals during the last century cannot but fall heavily upon these also. It is not too much to say that it is highly probable that a large proportion of the insects at present existing in the world will become extinct before their existence is even known to scientific men.

Yours faithfully,
W. F. KIRBY.

THE "WILSON PHENOMENON" OF SOLAR SPOTS.

To the Editor of KNOWLEDGE.

SIR,—In his valuable work, "Anleitung zur Durchmusterung des Himmels," published in 1880, Dr. Klein states (page 60) that Wilson was anticipated in his observation of the phenomenon of the varying position of the umbra in the penumbra of a solar spot as it passes across the disc by Maximilian Ludwig Christoph Schülen, of Essingen, in Würtemberg, and this statement is adopted in the last edition of Webb's "Celestial Objects for Common Telescopes."* It is, however, founded on a mistake, the source of which is easy to trace. Wilson was first led to his view that the solar spots were depressions in the photosphere by observations of a great spot which appeared in November, 1769, and he at once communicated his perception of the phenomenon now usually called by his name to the *London Chronicle*. But he did not send his paper on the subject (in which later observations confirming his view are communicated) to the Royal Society until 1773, and it appears in the *Philosophical Transactions* for 1774. No doubt it was by that that foreign astronomers obtained knowledge of his observations. Schülen's (in which he also noticed, he tells us, the funnel-shaped appearance of several spots) were made in the summer of 1771, and communicated first to a newspaper in Stuttgart, the substance afterwards appearing in papers in Switzerland and other places. From that time he heard no more of the matter until, in 1777, he was surprised to see in a French publication the discovery mentioned and ascribed to Wilson.

The Rev. F. Wollaston, and also Lalande, expressed their dissent from Wilson's views on the ground that the phenomenon in question is not *always* seen. He replied in the *Philosophical Transactions* for 1783; and surely the objection was insufficient, as some penumbræ might be much shallower than others, too shallow indeed to show the phenomenon in question. It does not appear that he ever heard of Schülen's observations. The latter published at Nördlingen, in 1782, a small treatise under the title "Beiträge zur Dioptrik und Geschichte des Glases," in which he narrates the facts above mentioned respecting his own observations, evidently unaware that Wilson had really anticipated him by more than a year.

As to the phenomenon itself, it is well known that that most persevering and careful sunspot observer, the Rev. F. Howlett, has not in his long course of observations, now extending over thirty-five years, recognized any such funnel-shaped appearance. A letter appears from him on this subject in the number of KNOWLEDGE for September, 1889, and it is open to any Fellow of the Royal Astronomical Society to study the long series of sunspot observations presented by him to the Society.

What are we then to conclude? It appears to me that the case is one of those in which a perception given from observations made with small instruments and low powers fails to be seen under the application of larger instruments and higher powers, which furnish clearer and more distinct images of matters of detail; and this is also the view of Dr. Klein.

Schülen's observations, it may be remarked, were made with a non-achromatic telescope of 13½ feet focal length, using a power of about 100. Wilson's telescope was a Gregorian reflector of 26 inches focus, which magnified 112 times. I need hardly refer to the way in which Mr. Howlett's observations have been made, and how it enables his drawings to bring out the minute details of the spots and their surroundings. We must surely concede that the penumbral depression is, in the vast majority of cases, exceedingly shallow.

Yours faithfully,
Blackheath, November 7th, 1892. W. T. LYNN.

THE LIFE-HISTORY OF STARS.

To the Editor of KNOWLEDGE.

SIR,—Various theories as to the evolution of stars and their subsequent decadence have appeared from time to time, but they have hitherto been purely theoretical. It seems to me that observation can throw some light on the question; and as far as I have been able to follow its guidance, this light leads in a rather unexpected direction.

A star cooling down will of course fade away gradually, and as the last light which a cooling body emits is red, it was at one time supposed that red stars were in this state of decadence. It seems pretty certain, however, that red stars owe the colour of their light not to their low temperature, but to absorption by an intervening medium.

The best observational test seems to me to be this: If a star has cooled down, and lost a considerable part of its light, it will probably be nearer to us than other stars of the same magnitude; for if its original light was restored, its magnitude would be considerably increased. And if the class of stars which give a particular kind of light are, in the average, nearer to us than stars of the same mag-

* In that work Schülen's name appears erroneously as Schüler.

nitude which give other kinds of light, this class probably consists of cooled-down stars.

It will be long before our observations on parallax are sufficiently numerous and accurate to enable us to decide this question directly; but there are two other indications of nearness to which we can appeal during the interval. One of these is large proper motion. The other is a computable orbit in the case of a binary star; for I think a pair of stars, separable in the telescope, but revolving so rapidly as to enable an orbit to be computed from the comparatively short range over which our observations extend, must be among our nearer neighbours.

I have tried both these tests and am still making some computations on the subject. The result of both tests is the same. The stars which are nearer to us than other stars of the same magnitude are those whose spectrum is of the type of Capella or Procyon, designated by the letter F in the *Draper Catalogue*.

Comparing the spectrum of a star of this class with that of Aldebaran for instance, we can easily see how the latter might be transformed into the former by the process of cooling. The great number of dark lines in the spectrum of Aldebaran are due to absorption by gases in the atmosphere of the star. As the star cools, many of these gases will condense and the lines due to their absorption will disappear from the spectrum. Partial condensation, again, will render the lines thinner and less dark. These changes will make the spectrum more similar to that of Capella. I do not, indeed, see how a Sirian star could be changed into one of the type of Aldebaran. Mr. Maunder is very probably right in thinking that Sirian and solar stars are physically distinct and do not represent different stages of star-life; but it may, notwithstanding, be true that the Capellan type represents the cooled-down condition of a solar star, and perhaps the higher temperature of the surface of emission in the case of stars of the type of Arcturus or Aldebaran may be indicated by a greater extension of the ultra-violet spectrum. Such an extension undoubtedly exists in the case of Arcturus.

The sun may be regarded as a Capellan star. Mr. Gore not long since maintained in your columns that the sun was a very dull star compared with all others in respect of which we possessed the means of comparison. Should further observations confirm this result, it will strengthen the evidence for the cooled-down condition of the Capellans. With regard to the binary stars to which I have referred the extraordinary brilliancy of γ *Leonis* has been regarded as an exception to the rule as to the greater brilliancy of the Sirians. This star, however, is one of the few binaries with computed orbits whose spectrum is of the Arcturian type, and therefore does not affect my conclusion as to the dulness of the Capellans.

I may perhaps remark that Sirian stars of the class B, which exhibit a number of fine lines in addition to the hydrogen-lines in their spectra, have less proper motion than ordinary Sirian stars. The difference here also may result from condensation.

Should this hypothesis be borne out by further observation the history of the sun may assist in explaining the past geological changes on the earth. There would not be a continuous loss of heat and light in consequence of the cooling. The condensation of vapours in the sun's atmosphere, and consequent diminution in the absorption, might even have the contrary effect; while if they formed into clouds above the photosphere before sinking beneath it we might have a season of great cold.

Truly yours, W. H. S. Monck.

[I do not agree with my friend Mr. Monck that we may assume that the oldest stars are the coolest. The late Mr. Homer Lane, of Washington, showed that a gaseous sphere, losing temperature by radiation and contracting under its own gravity, would actually grow hotter until it ceased to be a "perfect gas" obeying Boyle's law of pressure and density. Mr. Lane's theory is a necessary consequence of the kinetic theory of gases, and those who accept the nebular hypothesis and believe that stars have developed from faintly glowing gaseous masses are forced to assume that during a long period they have grown hotter, and that such stars as are still gaseous are still growing hotter.

We must not be misled by any supposed analogy between the change in tint of a cooling solid and a cooling mass of gas. While a cooling solid passes from white down to a dull cherry-red colour before it ceases to be luminous, some vapours actually give in the electric arc longer lines at the blue end of their spectrum than at the red—that is, the vapour gives out blue light in an outer and cooler region of the electric arc than that in which it gives out red and blue light. But if the stars are like our sun, it is probable that we do not receive the greater part of the light given out by their gaseous masses, which is nearly all intercepted by their photospheres. It is the continuous spectrum of the solar photospheric cloud layer which constitutes the chief light of the sun, and even this reaches us through the solar corona and chromosphere, which subtract many of the wave-lengths.

Therefore, in looking at the light of the stars, if we are to judge by solar analogies, we are observing the continuous spectrum of a comparatively thin layer of incandescent liquid or solid particles, through various depths and various types of stellar coronas and stellar chromospheres. The stellar spectra, when we succeed in fully deciphering and interpreting them, will enable us to determine the qualities and condition of the matter surrounding the stellar photospheres rather than the constituent elements and condition of the matter contained within the stellar photospheres.—A. C. Ranyard.]

STAR-CLUSTER NEAR SIRIUS OBSERVED BY ARISTOTLE.

To the Editor of Knowledge.

Sir,—I cannot find any reference in modern astronomical works to a very ancient observation of the star-cluster near Sirius, which may possibly be of interest to some of your readers. The description is by Aristotle, who has been too much depreciated as a natural historian and philosopher in modern times in consequence of the absurd claim to almost infallibility made on his behalf in the Middle Ages.

The passage to which I refer is in Book I., chapter 6, of his "Meteorologics," where arguing against those who thought that comets were produced by a conjunction of planets, he says that some of the fixed stars have a tail, and that not only the Egyptians assert this, but he can confirm it by his own observation. "For a certain star of those in the thigh of the Dog has a tail, though a dim one; for its light appears feeble to those who fix their gaze upon it, but greater to those who regard it more indirectly."

It is evident that the object thus spoken of is the cluster numbered 41 in the catalogue of Messier, who says that it resembles a nebula under a small power, but appears as a cluster of stars when a higher one is used. In Herschel's "General Catalogue" it is No. 1454; in that of Dr. Dreyer (where there is a misprint in the numerical reference to Messier's list) it is No. 2287. The cluster is readily visible to the naked eye, and is situated about 4° to the south of Sirius.

Yours faithfully,

Blackheath, November 7th, 1892. W. T. Lynn.

XUM

THE FACE OF THE SKY FOR DECEMBER.

By HERBERT SADLER, F.R.A.S.

DURING October and the beginning of November, sunspots have been not *quite* so plentiful and large as in the spring. The following are conveniently observable minima of two Algol-type variables:—Algol, December 2nd, 4h. 0m. P.M.; December 17th, 0h. 5m. A.M.; December 19th, 8h. 53m. P.M.; December 22nd, 5h. 42m. P.M. U Cephei, December 4th, 9h. 19m. P.M.; December 9th, 8h. 58m. P.M.; December 14th, 8h. 38m. P.M.; December 19th, 8h. 18m. P.M.; December 24th, 7h. 58m. P.M.; December 29th, 7h. 38m. P.M.

Mercury is an evening star during the first week in December, and a morning one during the last half of it, but owing to his great southern declination he will be liable to be obscured by mists near the horizon. He sets on the 1st at 4h. 52m. P.M., or one hour after sunset, with a southern declination of 24° 52′, and an apparent diameter of $8\frac{1}{4}''$, $\frac{34}{100}$ths of the disc being illuminated. After this he rapidly approaches the Sun, being in inferior conjunction on the 12th. On the 22nd he rises at 6h. 17m. A.M., or 1h. 49m. before the Sun, with a southern declination of 19° 27′, and an apparent diameter of 8·0″, $\frac{3}{10}$ths of the disc being illuminated. On the 27th he rises at 6h. 13m. A.M., or 1h. 55m. before the Sun, with a southern declination of 20° 15′, and an apparent diameter of $7\frac{1}{4}''$, $\frac{5}{10}$ths of the disc being illuminated, and the planet being at his greatest brightness during the month. On the 31st he rises at 6h. 18m. A.M., or 1h. 50m. before the Sun, with a southern declination of 21° 9′, and an apparent diameter of $6\frac{1}{2}''$, $\frac{63}{100}$ths of the disc being illuminated. During the latter half of the month Mercury describes a curved path in Ophiuchus, in a region almost barren of naked eye stars.

Venus is a morning star, rising at 4h. 16m. A.M., or $3\frac{1}{2}$ hours before the Sun, with a southern declination of 11° 17′, and an apparent diameter of $13\frac{1}{3}''$ $\frac{8}{10}$ths of the disc being illuminated, and her brightness being about what it was at the end of last February. On the 16th she rises at 5h. 3m. A.M., or 3 hours before the Sun, with a southern declination of 16° 55′, and an apparent diameter of $12\frac{1}{2}''$, $\frac{83}{100}$ths of the disc being illuminated. On the 31st she rises at 5h. 44m. A.M., or 2h. 24m. before the Sun, with a southern declination of 20° 59′, and an apparent diameter of 12·0″, $\frac{87}{100}$ths of the disc being illuminated, and her brightness being about what it was at the end of January. At 7h. A.M. on the 20th a 9th magnitude star will be 26″ north of the planet. During the month Venus passes from Virgo through Libra into Scorpio. When rising on the 23rd she is about 36′ *nf* the 3rd magnitude star β Scorpii, and at 6h. A.M. on Christmas Day she is $\frac{3}{4}$ of a minute of time preceding and 6′ south of ν Scorpii, $4\frac{1}{4}$ magnitude, β being a pretty double star, and ν being a triple in moderate-sized telescopes; both of the large stars composing β and ν being again double in large instruments.

Mars is an evening star, but is rapidly getting fainter and smaller, though he is in a much better position as regards elevation above the horizon. He sets at 11h. 38m. P.M. on the 1st, with a southern declination of 7° 30′, and an apparent diameter of 9·5″, the defect of illumination on the following limb being obvious. His brightness is then only one-eighth of what it was at opposition. On the 16th he sets at 11h. 38m. P.M., with a southern declination of 3° 23′, and an apparent diameter of 8·5″. On the 31st he sets at 11h. 36m. P.M., with a northern declination of 0° 45′, and an apparent diameter of 7·6″, his brightness being then only one-thirteenth of what it was at opposition. He is in quadrature with the Sun at midnight on the 9th. During December Mars describes a direct path from Aquarius into Pisces. At 8h. 30m. P.M. on the 2nd a $9\frac{1}{2}$ magnitude star will be 20″ north of the planet. Early on the evening of the 5th Mars will be 12′ south of the 4th magnitude star ϕ Aquarii, and at about 9 P.M. on the 7th he will be $7\frac{1}{2}'$ north of the $5\frac{1}{2}$ magnitude star 96 Aquarii.

Ceres is an evening star, southing on the 14th at 9h. 35m. P.M., with a northern declination of 9° 35′. At the end of the month she is as bright as an 8th magnitude star. During December she pursues a short retrograde path from Taurus into the borders of Aries. At about 7h. 30m. P.M. on the 4th she is 20′ south of the $6\frac{1}{4}$ magnitude star Weisse's Bessel^2, iiih. 275, and about 7 P.M. on the 26th she is $7\frac{1}{2}'$ north of and a little following the $6\frac{1}{4}$ magnitude star B. A. C. 987. Vesta is also an evening star, southing on the 14th at 9h. 19m. P.M., with a northern declination of 8° 48′. At the end of the month she is as bright as a $7\frac{1}{3}$ magnitude star. During December she pursues a retrograde path in Cetus, being 24′ north of the 5th magnitude star λ Ceti at 9h. P.M. on the 16th.

Jupiter is an evening star, still holding his position as the most magnificent object in the evening sky. On the 1st he rises at 1h. 47m. P.M., with a northern declination of 4° 37′, and an apparent equatorial diameter of 45·1″, the phase on the following limb being now very apparent. On the 16th he rises at 0h. 47m. P.M., with a northern declination of 4° 54′, and an apparent equatorial diameter of 43·0″, the phase amounting to 0·4″. On the 31st he rises at 11h. 48m. A.M., and souths at 6h. 18m. P.M., with a northern declination of 5° 1′, and an apparent equatorial diameter of 40·9″. During the greater part of the month he describes a short direct path in Pisces. At 2 P.M. on the afternoon of the 27th he is in conjunction with the Moon, $31\frac{1}{2}'$ to the north of her, and the same evening at 9 P.M. he is in conjunction with the 6th magnitude star 73 Piscium, Jupiter being $10\frac{1}{4}'$ south. The following phenomena of the satellites occur while Jupiter is more than 8° above and the Sun 8° below the horizon. On the 1st an occultation reappearance of the third satellite at 5h. 45m. P.M.; an eclipse disappearance of the same satellite at 8h. 5m. 52s. P.M.; and an eclipse reappearance at 10h. 1m. 59s. P.M. On the 3rd an occultation disappearance of the first satellite at 9h. 54m. P.M. On the 4th a transit ingress of the first satellite at 7h. 3m. P.M.; of its shadow at 8h. 12m. P.M.; a transit egress of the first satellite at 9h. 17m. P.M.; an occultation disappearance of the second satellite at 10h. 11m. P.M.; and a transit egress of the shadow of the first satellite at 10h. 26m. P.M. On the 5th an eclipse reappearance of the first satellite at 7h. 41m. 49s. P.M. On the 6th a transit egress of the shadow of the first satellite at 4h. 55m. P.M.; a transit ingress of the second satellite at 5h. 8m. P.M.; a transit ingress of its shadow at 7h. 30m. P.M.; a transit egress of the satellite at 7h. 41m. P.M., and of its shadow at 9h. 58m. P.M. On the 8th an occultation disappearance of the third satellite at 7h. 5m. P.M., and its reappearance from occultation at 9h. 27m. P.M. On the 10th an occultation disappearance of the first satellite at 11h. 44m. P.M. On the 11th a transit ingress of the first satellite at 8h. 54m. P.M.; a transit ingress of its shadow at 10h. 8m. P.M., and a transit egress of the satellite one hour later. On the 12th an occultation disappearance of the first satellite at 6h. 12m. P.M., and its reappearance from eclipse at 9h. 37m. 39s. P.M. On the 13th a transit egress of the first satellite at 5h. 36m. P.M.; of its shadow at 6h. 50m. P.M.; a transit ingress of the second satellite at 7h. 37m. P.M.; of its shadow at 10h. 7m. P.M.; and a transit egress of the satellite itself three minutes later. On the 15th an eclipse

reappearance of the second satellite at 6h. 49m. 12s. P.M.; and an occultation disappearance of the third satellite at 10h. 48m. P.M. On the 18th a transit ingress of the first satellite at 10h. 45m. P.M. On the 19th a transit ingress of the shadow of the third satellite at 6h. 12m. P.M.; an occultation disappearance of the first satellite at 8h. 5m. P.M.; a transit egress of the shadow of the third satellite at 8h. 19m. P.M., and an eclipse reappearance of the first satellite at 11h. 33m. 31s. P.M. On the 20th a transit ingress of the first satellite at 5h. 14m. P.M.; a transit ingress of its shadow at 6h. 32m. P.M.; a transit egress of the satellite at 7h. 28m. P.M., and of its shadow at 8h. 45m. P.M.; a transit ingress of the second satellite at 10h. 9m. P.M. On the 21st an eclipse reappearance of the first satellite at 6h. 2m. 33s. P.M. On the 22nd an occultation reappearance of the second satellite at 6h. 56m. P.M.; an eclipse disappearance of the satellite at 7h. 4m. 13s. P.M., and its reappearance at 9h. 25m. 41s. P.M. On the 26th a transit egress of the third satellite at 7h. 9m. P.M.; an occultation disappearance of the first satellite at 9h. 58m. P.M., and a transit ingress of the shadow of the third satellite at 10h. 15h. P.M. On the 27th a transit ingress of the first satellite at 7h. 7m. P.M.; a transit ingress of its shadow at 8h. 28m. P.M.; a transit egress of the satellite at 9h. 21m. P.M., and of its shadow at 10h. 41m. P.M. On the 28th an eclipse reappearance of the first satellite at 7h. 58m. 24s. P.M. On the 29th a transit egress of the shadow of the first satellite at 5h. 10m. P.M.; an occultation disappearance of the second satellite at 6h. 55m. P.M.; an occultation reappearance of the same satellite at 9h. 29m. P.M., and its eclipse disappearance at 9h. 41m. 11s. P.M. On the 31st a transit egress of the shadow of the second satellite at 7h. 13m. P.M.

Saturn does not rise till after midnight on the last day of December, and we therefore defer giving an ephemeris of him until next year. He is occulted by the Moon, though the phenomenon is not of course visible in the British Islands, on the evening of the 12th. Uranus does not rise before 3 A.M. at the end of the month, and is therefore, for the purposes of the amateur observer, invisible.

Neptune is an evening star, and is excellently situated for observation, coming into opposition with the Sun on the 1st, at a distance from the earth of about 2,680,700,000 miles. He rises on the 1st at 3h. 54m. P.M., with a northern declination of 20° 22′, and an apparent diameter of 2·7″; on the last day of the month at 1h. 53m. P.M., with a northern declination of 20° 15′. During December he describes a short retrograde arc in Taurus, between τ and ϵ, to the N.E. and N.W. of the $5\frac{3}{4}$ magnitude star Weisse's Bessel^2, ivh. 650. At 11h. 40m. P.M. on the 2nd he will be 1′ 0″ due north of a 9th magnitude star. A map of the small stars near his path will be found in the *English Mechanic* for October 28th.

December is a fairly favourable month for shooting stars, the chief showers being those of the Geminids on December 9th—12th, the radiant point being in R.A. 7h. 0m., and north declination 32°, rising about 4h. 10m. P.M., and setting at 1h. 40m. A.M., and of the Andromedes, occurring on the evenings of the 26th and 27th, the radiant point being in R.A. 1h. 40m. and north declination 43°, the shower being circumpolar. It seems probable that a fine display will occur this year.

The Moon is full at 2h. 17m. A.M. on the 4th; enters her last quarter at 2h. 30m. A.M. on the 11th; is new at 8h. 13m. A.M. on the 19th; and enters her last quarter at 9h. 22m. P.M. on the 26th. She is in perigee at 3·0h. A.M. on December 2nd (distance from the earth 224,630 miles); in apogee at 1·3h. P.M. on the 15th (distance from the earth 252,240 miles); and in perigee at 0·2h. P.M. on the 31st (distance from the earth 222,320 miles). She is at her greatest western libration at 5h. 48m. A.M. on the 9th, and her greatest eastern at 5h. 21m. P.M. on the 24th.

Chess Column.

By C. D. Locock, B.A.Oxon.

ALL COMMUNICATIONS for this column should be addressed to the "CHESS EDITOR, *Knowledge Office*," and posted before the 10th of each month.

Solution of November Problem:—

Key-move: 1. K to Kt8.

If 1. . . . K to Q5, 2. R to Q2ch, etc.
If 1. . . . P to Q5, 2. Q to Kt7, etc.
If 1. . . . K to Q6, 2. Q to KB4, etc.

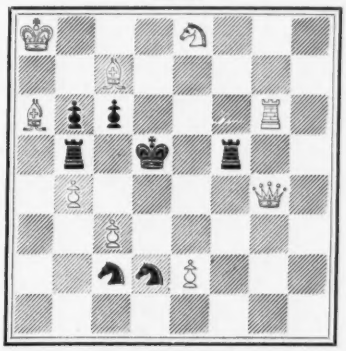
CORRECT SOLUTIONS received from Alpha, A. Rutherford, and H. S. Brandreth.

PROBLEM.

By E. HALLIWELL, Bolton.

First Prize in *Bristol Mercury* Tourney.

BLACK.



WHITE.

White to play, and mate in two moves.

The subjoined game resulted in the first defeat sustained by Mr. Lasker at the Manhattan Club, New York. The winner is well known as one of the strongest American players.

RUY LOPEZ.

WHITE (E. Lasker).	BLACK (A. B. Hodges).
1. P to K4	1. P to K4
2. KKt to B3	2. QKt to B3
3. B to Kt5	3. P to Q3
4. QKt to B3 (*a*)	4. B to Q2
5. Castles	5. KKt to K2 (*b*)
6. P to Q3 (*c*)	6. Kt to Kt3
7. B to K3 (*d*)	7. B to K2
8. P to Q4	8. Castles (*e*)
9. B to B4	9. B to Kt5?
10. P to Q5 (*f*)	10. Kt to Ktsq
11. P to KR3	11. B × Kt (*g*)
12. Q × B	12. P to KB4
13. P × P	13. Kt to R5
14. Q to Kt4 (*h*)	14. Kt × BP
15. B to Q2	15. Kt to Q2
16. B to Q3	16. P to KKt3
17. Kt to K4	17. R to B2
18. QR to Ksq (*i*)	18. Q to KBsq
19. Kt to B3	19. P to QR3
20. Kt to Qsq	20. Q to Kt2

XUM

21. B to B3	21. QR to KBsq
22. P to Kt4 (*j*)	22. B to Qsq
23. B to Kt2	23. Kt to B3
24. Q to QB4	24. Kt to R4 (*k*)
25. P to KB4	25. P to QKt4
26. Q to B6	26. Kt to K2 !
27. Q × RP	27. Kt × BP
28. Q × KtP	28. Q to R3
29. Kt to B2 (*l*)	29. Q to Kt4
30. B to K4	30. Kt to KB4
31. Q to B4 (*m*)	31. Kt to Kt6
32. KB to B3	32. Kt × R
33. R × Kt	33. Q to R5 !
34. Q to K4 (*n*)	34. Kt × Pch !
35. Kt × Kt	35. Q × Q
36. B × Q (*o*)	36. R × Rch
37. K to R2	37. R to K8
38. B to Q3	38. P to K5
39. B to B4	39. B to B3
40. B × B	40. R × B
41. K to Kt3	41. P to K6
42. Kt to Kt5	42. R to B7
43. B to Q3	43. R to KKt8
44. Resigns.	

NOTES.

(*a*) New, but unenterprising. 4. B × Ktch and 4. P to Q4 are both stronger.

(*b*) A very good development in this position. Black will evidently have the first opportunity for advancing his P to KB4.

(*c*) The Pawn should go two squares; *vide* his 8th move. 6. B to QB4 (threatening Kt to KKt5) would be met by Kt to R4 or Kt to Kt3.

(*d*) Mr. Lasker inherits Paul Morphy's predilection for this move. In the present case the Bishop seems well posted, being unassailable by either of the adverse Knights.

(*e*) Black does well in refusing to exchange. Taking the Pawn would give freedom, by slaughter or otherwise, to White's useless King's Knight. At his next move, however, he should play K to Rsq, with a view to the advance of the KBP.

(*f*) Seldom advisable, the present instance being no exception. He might play with safety 10. P × P, QKt × P; 11. B to K2.

(*g*) The Bishop is too valuable to exchange. We should much prefer B to Bsq, to be followed by working the QKt round to KB5 if possible.

(*h*) The Queen is liable to be attacked here later on. Probably 14. Q to K2 would be a safer line of play.

(*i*) This results in overcrowding. There seems no objection to the obvious Kt to Kt5. White's play now becomes unintelligible for a time.

(*j*) This advance of the unsupported QKtP is a favourite manœuvre of Mr. Lasker's. On principle it is clearly weakening for the end-game.

(*k*) Prettily played. Clearly White cannot play 25. P to KKt4, Kt to B5; 26. P × Kt? Nor would he gain anything by 26. Q × Kt, P × Q; 27. B × Q, Kt × B, etc. After this Black gives up a Pawn in order to secure the KBP with safety, and at the same time leave the White Queen out of play.

(*l*) He is compelled to guard the RP which will be threatened next move; but there was another way by K to R2, which was possibly better.

(*m*) The Queen continues to return by easy stages. He might have saved the exchange among other ways by 31. B to KB3.

(*n*) The Queen is obviously threatened. 34. K to R2 is useless on account of 34. . . . Kt × KtP ! The same objection applies to 34. Q to B3. The game in fact cannot be saved, and Mr. Hodges proceeds to bring the game to a clever and rapid termination.

(*o*) A process in which he is not assisted by Mr. Lasker, who overlooked the best reply at this point, and discovered it eight moves later.

CHESS INTELLIGENCE.

In the Handicap Tournament of the British Chess Club, Mr. Trenchard has come out the winner of one section: in the other Mr. Donisthorpe has the best chance. The winner of this section will play Mr. Trenchard for the first prize.

Mr. Lasker has been playing the leading New York players with almost uniform success. It is hoped that a match with S. Lipschütz will be arranged.

January 28th is the date fixed for the North *v.* South match at Birmingham. There will be 100 players on each side, with ten reserves. Mr. Blackburne has accepted the post of umpire, no sinecure in a match arranged on such a gigantic scale, and with the time of play probably limited to about four hours.

A match by correspondence is in progress between the Berlin and Leipsic Clubs. The former are represented by Messrs. Alapin, Hirschfeld, Von Scheve, Walbrodt and Winawer: while the Leipsic committee consists of Messrs. Bardeleben, Max Lange and Mieses. Two games are being played, the time limit averaging five days a move.

A match was played recently at Newcastle between Messrs. Bird and Heywood, Chess Editor of the *Newcastle Chronicle*. Three games were played on even terms, of which Mr. Bird won two and lost one. Three games at the odds of Pawn and move resulted in equality. Three other games, in which Mr. Bird conceded the large odds of Pawn and two moves, resulted in one win to Mr. Heywood and one drawn game: the final game was not played, Mr. Bird resigning the game and the match.

A second edition of the "Chess Openings" by Messrs. Freeborough and Ranken is in the press. The price will be 6s. 6d. net.

CONTENTS OF No. 85.

	PAGE
The Disaster at St. Gervais. By the Right Hon. Sir Edward Fry, LL.D., F.R.S.	201
Caterpillars—I. By E. A. Butler	204
The Rev. John Michell, Astronomer and Geologist. By John Richard Sutton, B.A.Cantab.	206
Bye-Products *versus* Waste-Products. By Vaughan Cornish, M.Sc., F.C.S.	208
The Movements in the Line of Sight of Stars and Nebulæ. By Miss A. M. Clerke	209
Notices of Books	211
Letter:—R. H.	212
The Oldest Mammals. By R. Lydekker, B.A.Cantab.	212
The New Geology. By the Rev. H. N. Hutchinson, B.A., F.G.S.	216
The Face of the Sky for November. By Herbert Sadler, F.R.A.S.	218
Chess Column. By C. D. Locock, B.A.Oxon.	219

TERMS OF SUBSCRIPTION.

"KNOWLEDGE" as a Monthly Magazine cannot be registered as a Newspaper for transmission abroad. The Terms of Subscription per annum are therefore as follows:—To any address in the United Kingdom, the Continent, Canada, United States, Egypt, India, and other places in the Postal Union, the Subscription is 6 shillings, including postage; or 1 dollar 50 cents; or 6 marks; or 7 francs 50 cents.
For all places outside the Postal Union, 5 shillings in addition to the postage.

Communications for the Editor and Books for Review should be addressed Editor, "KNOWLEDGE" Office, 326, High Holborn, W.C.

XUM